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THE DEVELOPMENT OF TEXTUAL BEHAVIOR AND ITS FUNCTION IN COMMUNICATION.

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FIVE STUDIES ARE REPORTED OF OPERANT CONDITIONING AND LANGUAGE DEVELOPMENT PRINCIPLES IN READING. THE FIRST STUDY OUTLINED THE RATIONALE AND PRINCIPLES UNDERLYING THE PROJECT. THE SECOND STUDY INITIATED AND REFINED APPLICATIONS OF REINFORCEMENT PROCEDURES FOR STUDYING EFFECTS OF DISCRIMINATION TRAINING ON READING. STUDY NUMBER THREE DEMONSTRATED THE RELEVANCE OF REINFORCEMENT FOR READING ACQUISITION. THE FOURTH STUDY INVOLVED 4-YEAR-OLD CHILDREN (2 BOYS, 1 GIRL) ENTERING THE CAMPUS LABORATORY SCHOOL. THE CHILDREN USED A RESPONSE REINFORCEMENT APPARATUS WHICH PROVIDED CANDY, PENNIES, OR TOYS AS REWARDS FOR APPROPRIATE RESPONSES ON TWO TYPES OF LANGUAGE DISCRIMINATION TASKS. THE SYSTEM PROVIDED SELF-VARIABLE REINFORCERS. RESULTS DEMONSTRATED THE FEASIBILITY OF USING THE EXPERIMENTAL PROCEDURE FOR LONG PERIODS WITH INDIVIDUAL SUBJECTS. RESULTS AND CONCLUSIONS FROM THE FIRST FOUR EXPERIMENTS WERE THEN USED IN FOUR SEPARATE EXPERIMENTS DESIGNED TO STUDY THE MANNER OF DEVELOPING EVALUATIVE MEANINGS IN READING. THESE EXPERIMENTS IN THE FIFTH STUDY WERE CONDUCTED CONCURRENTLY. EIGHTY STUDENTS IN THE FOURTH AND FIFTH GRADES PARTICIPATED. CHILDREN WERE BROUGHT UNDER EXPERIMENTER CONTROL AND REQUIRED TO RESPOND TO A FORCED CHOICE FORMAT FOR TESTING SEMANTIC DIFFERENTIATION. SUBJECTS WERE REQUIRED TO SELECT SYLLABLES ASSOCIATED WITH 20 POLAR EVALUATIVE TERMS RANDOMLY PRESENTED WITH 12 RANDOMLY INSERTED BUFFER TERMS. CONDITIONING PROCEDURES ESTABLISHED EVALUATIVE MEANINGS IN ALL BUT ONE GROUP. RESULTS OF AN ANALYSIS OF VARIANCE ARE PRESENTED COMPARING SEMANTIC DIFFERENTIAL PERFORMANCE AMONG THE FIVE STUDY EXPERIMENTS. (WN)

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THE DEVELOPMENT OF TEXTUAL BEHAVIOR AND ITS FUNCTION IN COMMUNICATION

Cooperative Research Project No. 1048

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Table of Contents

Acknowledgements ii

List of Tables iv

List of Figures v

I. Introduction 1

II. Study I. A Comparison of the Development of Speech and Reading Behavior with Implications for Research
Arthur W. Staats and Carolyn K. Staats 3

III. Study II. The Effects of Discrimination Pretraining on Textual Behavior
Carolyn K. Staats, Arthur W. Staats, and Richard E. Schutz . 19

IV. Study III. The Conditioning of Textual Responses Using "Extrinsic" Reinforcers
Arthur W. Staats, Carolyn K. Staats, Richard E. Schutz, and Montrose Wolf 28

V. Study IV. A Reinforcer System and Experimental Procedure for the Laboratory Study of Reading Acquisition
Arthur W. Staats, Karl A. Minke, Judson R. Finley, Montrose Wolf, and Lloyd O. Brooks 39

VI. Study V. An Application of Mowrer's Sentence Conditioning Paradigms in Developing Evaluative Meaning
Richard E. Schutz and Harold Naumoff 62

VII. References 70

List of Tables

1 Means and SDs of Mental and Chronological Age in Months for Study II Subjects 21

2 Analysis of Variance of Correct Textual Responses for Study II Subjects 25

3 Analysis of Data for Counterbalanced Groups Within Each Experiment of Study VI 68

4 Comparisons Among the Four Experiments of Study VI 68

List of Figures

1 Learning Curves for Study II Subjects 24

2 Data for the No-Reinforcement--Reinforcement Subjects in Study III 34

3 Data for the Reinforcement--No-Reinforcement--Reinforcement Subjects in Study III 36

4 Laboratory Apparatus for the Experimental Study of Reading Behavior Employed in Study IV 44

5 Learning Curves for Subject 1 of Study IV 48

6 Learning Curves for Subject 2 of Study IV 50

7 Learning Curves for Subject 3 of Study IV 52

8 Schematization of Conditioning Procedures Employed in Study VI 63

I. Introduction

A good deal of productive theorizing and experimenting has occurred in the application of learning principles to the area of verbal behavior in recent years. Notable advances have been achieved along two major fronts: investigation of the operant conditioning of verbal behavior and investigations of the semantic properties of language, where classical conditioning principles seem predominately involved. The studies reported in this Final Report take cognizance of the theory and constitute further steps in the advance of research in each of these two areas.

Professor B. F. Skinner has played an important role in developing operant learning principles and in stimulating studies involving their application to complex behavior. Many of these studies have involved children in a variety of learning situations. Recently Skinner has extended his systematic formulations to language behavior. His book, Verbal Behavior (1957) attempts to provide a comprehensive description and explanation of this subdivision of human behavior. The reported research systematically investigates the phenomenon which Skinner designates as "textual behavior." The term refers to vocal behavior which is controlled by written or printed stimuli. It will be noted that this is an important aspect of reading. In Skinner's terms, "When we say that a person is 'able to read' we mean that he will behave in certain ways under suitable circumstances involving a verbal nonauditory stimulus."

Although Skinner's presentation derives from an impressive experimental treatment of the behavior of organisms in general, his analysis of verbal behavior itself had not been subjected to extensive experimental verification. Skinner regards his presentation as "an exercise in interpretation rather than a quantitative extrapolation of rigorous experimental results." Several of the studies in the presently reported reserach were designed to provide the kind of experimental results necessary to empirically verify and extend Skinner's formulation. In addition, several of the studies deal with variables of immediate practical significance for the teaching of reading in the school situation.

Further, the studies to be reported utilize principles of language development and function derived from the application of classical conditioning principles to the semantic properties of language. A number of investigators, e.g., Mowrer (1954), Osgood (1957), Staats and Staats (1957, 1958), have been actively engaged in experimental investigations of the development of word meaning and the way in which word meaning is "transferred" in communication. This behavior too is recognized as an important aspect of reading skill. While previous studies in this area have used adult subjects almost exclusively, studies reported here extend the research to the development and function of language in early childhood.

In general, these theoretical developments underly the experimental investigation of language development in the research reported. The several studies reported lead toward experimental interpretation of the principles of operant conditioning and the principles of the development and transfer of word meaning as they function in reading. The specific studies to be reported include a theoretical analysis as well as several empirical studies.

The first study to be presented outlines the rationale and basic principles underlying the research project. The second study initiates the application of reinforcement procedures to the study of the effects of discrimination training on the later acquisition of reading. In the next stage of the project, a laboratory procedure was developed for training reading and a number of children were run under different conditions of reinforcement in order to construct an efficacious reinforcement system. Immediate reinforcement as well as token reinforcers backed up by toys or entertainments were used.

The results of some of these procedures formed the rationale for the next two studies which were conducted as more formal experiments. The first of these, Study No. 3, demonstrates the importance of reinforcement procedures for the acquisition of reading. Study No. 4 applies the results of all the previous experimentation to the development of an effective reinforcement system for work with children over extended periods of time while they are involved in complex learning tasks. (This study was not stipulated in the contract, but represents work additional to the contract). Since related research in the field has indicated the difficulties in producing a laboratory situation for the long term study of learning in children, the results of this study represents a considerable advance in experimental technology.

Study No. 5 includes four experiments which study the manner in which meaning is communicated in reading. These studies demonstrate that communication (i.e., the conditioning of meaning) may occur through visually presented verbal stimuli.

Since the findings of the project have been published, or are being prepared for formal publication, the format selected for this Final Report is that of a monograph, with each study presented as a discrete and complete unit.

II. Study I: A Comparison of the Development of Speech and Reading Behavior With Implications for Research*

Arthur W. Staats and Carolyn K. Staats

Recent experimental and theoretical work in experimental psychology provides a framework for understanding some of the special problems which exist in the development of language. The purpose of the present article is to extend a number of the established behavioral principles to the area of language development and to emphasize some of the special problems involved in the acquisition of reading skills.

The principles to be developed are those of operant conditioning or operant learning and the primary sources are Keller and Schoenfeld (1950) and Skinner (1957). In this respect, the present approach is like that of Gewirtz (1956), who discussed emotional dependence in these terms. The language activities of children are considered herein to be behaviors which are subject to these principles of acquisition. A full presentation of language development must include the principles of classical conditioning and the interaction of classical and operant principles in the development of word meaning. However, these principles will not be dealt with at this time.

Specifically, this paper will describe the principles by which speech responses in general, and speech responses to particular aspects of environmental stimuli, are developed into precise language behaviors. It will be pointed out that in certain respects the teaching of verbal responses to visually presented verbal stimuli (reading) deviates from the acquisition of speech in ways which make the acquisition of reading much more difficult. Consideration of the principles involved and the differences in the two types of learning should yield a better understanding of the problems involved in learning to read and thus suggest productive lines of research.

The Principles

Operant Learning

A simple and very general law of behavior is that a response followed by certain "consequences," which in everyday life are called rewards, will in the future occur more frequently. That is, the response will be strengthened. The objective term for such a consequence is positive reinforcer or reinforcing stimulus. On the other hand, a response whose "consequence" is the removal of an aversive state of affairs is also strengthened. Such a stimulus is called a negative reinforcer. Stimuli whose removal is reinforcing are called "unpleasant" or "punishing" in every day life.

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*This article ~~is presently in press~~ Appears in Child Development, 1962, 33, 831-846

Reinforcing Stimuli

Reinforcing stimuli may differ for different species and for different individuals within a species. Some stimuli have this reinforcing effect on a biological basis. Without any training these stimuli will be effective reinforcers. To a baby deprived of milk, milk as a stimulus object will strengthen any operant behavior it follows. Food, water, warmth, and other such stimuli are unlearned, or primary positive reinforcers. Conversely, since the removal of wet and chaffing diapers will strengthen the response of crying, this event constitutes a primary negative reinforcer.

There are many other stimuli which originally are not reinforcing, i.e., are neutral with respect to their effect upon the strength of behavior, but which become "secondary" reinforcers by being present when a reinforcing stimulus occurs. Depending on the type of reinforcer with which it is paired, the neutral stimulus may become either positive or negative, and will be effective in strengthening any operant behavior in the ways described.

In addition, responses may themselves become secondary reinforcers. This can occur because every response of an organism produces stimuli which, if frequently associated with reinforcement, may become reinforcing stimuli themselves.

Time and Scheduling of Reinforcement

Although detail is not possible here, some additional principles should be stressed. First, the time intervening between the response and the reinforcer is very important. The shorter the interval, the more the response is strengthened for future occasions. If the interval is too long, learning does not occur. Secondly, the schedule of presenting reinforcement is also crucial. For example, after a response has been reinforced many times it is possible to maintain the response at some strength by reinforcing it only a portion of the times it is emitted. The ratio of non-reinforced to reinforced trials may be slowly increased until the response is maintained in strength by very infrequent reinforcement.

Successive Approximation

Many responses occur so infrequently that it would be highly impractical to wait for their occurence so that they could be reinforced. However, operant learning can take place in a gradual manner. A response which ordinarily would not occur in finished form can be "shaped" by first rewarding gross approximations to the final response and then gradually reinforcing only the better approximations to the desired response. This type of shaping is possible because a particular response is actually a member of a class of similar responses. Each response has many variations and involves, prior to refined operant training, other closely related responses. Thus, reinforcing a response actually strengthens a class of responses which will include variants which are closer approximations to the final response desired. When the more desirable variants are selectively reinforced, a new class of responses will be strengthened which will include new variants even closer to the desired response, and these may then be reinforced. The process of differentiating out the desired variants in each class in a series of steps is called successive approximation.

Chaining

Every response produces characteristic stimuli, thus responses themselves may become "joined" into chains or series of responses through conditioning. One response, through the stimuli it produces, will come to elicit the next response, and so on. This is the principle of chaining. Most sequences of skilled movements are of this type, as are chains of associated word responses in adult language.

Extinction

Another important principle is that of extinction. A response which has been strengthened by reinforcement will weaken if it is no longer followed by reinforcement. Thus, to weaken a response to its pre-reinforcement strength, reinforcement should be withheld whenever that response occurs.

Discrimination and Generalization

For human adjustment it is important not only that a response be made, but also that it be made in the appropriate circumstances or stimulus situation. The principle of stimulus discrimination describes how a stimulus comes to control a particular response. When a response is reinforced in the presence of a certain stimulus and is not reinforced in the absence of the stimulus, that response will come to occur only in the presence of the stimulus. When the stimulus occurs, the response occurs. When the stimulus is withdrawn, the response does not occur.

In addition, when a particular stimulus has come to control a response, similar stimuli will, to the extent of their similarity, also control this same response. This is called the principle of stimulus generalization.

Extension of These Principles to Certain Aspects of Language Behavior

While these principles in their simple form will not account for all of language behavior, some significant applications of the principles may be made within the scope of this paper. The discussion will deal first with certain aspects of the development of the child's early language behavior, and then with some of the special problems in the acquisition of reading behavior.

Speech Learning

During the first month of life, for the most part a baby's vocal sounds do not resemble speech. Vocalization involves crying, a few squeaks, clucks, and so on. During the first several months, however, the infant produces varied sounds which have duplicates in human speech.

The extent to which the first behavioral development of this kind is due to maturational factors versus the effects of reinforcement history need not concern us here. It is important to note, however, that a study by Rheingold and Gewirtz has shown that this type of behavior can be operantly conditioned even at an early age, under the action of an adult's social response as the reinforcer. In this very simply conducted study, twelve 3-month-old infants were used as subjects. First, a preconditioning baseline tabulation was made for each infant. During this period the experimenter was in the view of the infant but maintained an expressionless face. During the conditioning phase the experimenter reinforced each vocal response by smiling, clucking, and lightly squeezing the infant's abdomen. In the third phase of the study, extinction, the experimenter again did not reinforce the speech responses. The authors found 1) that mean vocalizing rate was higher during conditioning than during baseline or extinction, and 2) the mean rate was higher during the second than during the first conditioning day (1957, p. 392). The importance of these results can be seen more clearly when it is realized that this primitive speech behavior is the basic class of behaviors from which more and more precise speech responses may be differentiated.

Sources of Reinforcement

Before discussing further the development of speech, the types of reinforcers which are effective in shaping early vocal behavior should be noted. One type of reinforcement is that which is delivered by the parents at the time of the response. This could involve primary reinforcers such as food, relief from pain, etc., or, as in the Rheingold and Gewirtz study, secondary reinforcers such as the smiles of the parents, and the sounds they make.

Another important source of reinforcement involved in the child's language development consists of the sounds which the child himself produces. Mowrer (1950) and Miller and Dollard (1941) have described the manner in which the sounds the child produces become secondary reinforcers and may shape early language development.

> Since the mother talks to the child while administering primary rewards such as food, the sound of the human voice should acquire secondary reward value. Because the child's voice produces sounds similar to that of his mother's, some of this acquired reward value generalizes to it...From this hypothesis it may be deduced that children talked to while being fed and otherwise cared for should exhibit more iterative and imitative babbling than children not talked to while being rewarded (1941, p. 277).

In the terms developed in the present discussion, the sounds of the mother's voice become secondary positive reinforcers because these sound stimuli have been paired with other positive reinforcers. On this basis it would be expected that a response on the part of the child which produced a sound that was in some way similar to sounds produced by the parents would be strengthened and would occur more frequently.

Further Developments in Early Speech

On the basis of recordings made of a child's vocalizations during the first year of life, Osgood has concluded that infants make "all the speech sounds that the human vocal system can produce, including French vowels and trills, German umlaut and gutteral sounds, and many that are only describable in phonetic symbols. This is in flat contradiction to the notion that the infant gradually 'becomes capable' of making various sounds" (1953, p. 684). Evidently the structures and muscular flexibility are present by which the infant can produce many different sounds--many more than he will eventually make habitually.

Although the infant may initially make all types of speech sounds, in time the frequency of making certain sounds undergoes a change. This child's vocal behavior becomes increasingly more like that of the vocal behavior of the adults in the child's environment (Irwin, O. C., 1948, 1952). This progression would be expected on the basis of certain sounds of the parents becoming positive conditioned reinforcers. As an example, the language environment of a child raised in an English-speaking home would consist of syllable sounds like ba, ma, da, kee, lo, foo, etc. Since these sounds occur frequently in the speech of the parents, and in the presence of positive reinforcers given by the parents, they become positive reinforcers. Vocal responses by the child which produced similar sounds would thus be immediately reinforced and the responses would increase in frequency. Responses which produced sounds which were not reinforcing in this way would extinguish, or not increase in strength.

On the basis of this principle, and after a series of such differentiations, from the infant's extended class of speech responses, the child's speech repertoire includes responses more and more like the syllables which occur in the adult speech of his language community. This type of verbal behavior is often called babbling. Many of the sounds now produced by the vocal responses will approximate word and phrase responses emitted by the parents. It is interesting to note, as would be expected on the basis of this analysis, that deaf children do not progress into the babbling stage of vocal development. Since the deaf child is not sensitive to the speech sounds they cannot become secondary reinforcers and strengthen his own vocal responses.

From the babbling stage to the development of the first few speech responses which are appropriately emitted involves continued differentiation of the class of babbling responses. However, when the child finally utters the first clearly recognizable words in the proximity of the parents, there is customarily immediate and strong reinforcement, and the child's verbal response class enters a new phase of more repid shaping. At this point the parents' direct and immediate reinforcement of speech responses probably assumes an important role in the shaping of the child's speech, although the self-reinforcement provided by saying words like those of the parents will continue to be effective. The parents now become more sensitive to the speech responses of the child and reinforce even close approximations to English words. Speech responses like "wahwah" may be reinforced with a drink of water, and "da" may be reinforced by the presentation of the child's toy dog. In this manner a rudimentary repertoire of speech responses is further differentiated out of the large class of vocal responses which the child formerly made.

Continued Shaping of Speech Through Successive Approximation

However, "wahwah, wahda, wuhda, wata, watah," and so on, are not examples of the precise speech sound of "water" which is made in the English speech community. Further successive approximation from several sources of reinforcement acts to gradually shape the speech responses of the child to more and more precise duplicates of adult speech.

There are several seurces of this differential reinforcement. First, adults or other children less familiar than the parents with the child's speech may not respond at all to the child's grosser verbal responses, thus reinforcing only the better pronunciations. In this way, the better responses child will be subjected to greater reinforcement and the poorer ones extinguished. Or better responses may be more quickly reinforced. For example, when the child emits a verbal response and is asked, "What did you say?", reinforcement is postponed, a further response is required, and this verbal response receives less strengthening than one to which the listener immediately makes an appropriate response. Thus, the differential reinforcement of better speech responses by parents and by others, especially in terms of the time of reinforcement, is responsible for the gradual shaping of better speech behaviors in the child.

Formation of Verbal Discriminations

Progress in speech development also involves discrimination training which results in a type of speech behavior that Skinner calls echoic behavior. What is meant by this term is that the child learns to echo, or repeat, what the parent says.

> An echoic repertoire is established in the child through "educational" reinforcement because it is useful to parents, teachers, and others. It makes possible a short-circuiting of the process of progressive approximation, since it can be used to evoke new units of response upon which other types of reinforcement may then be made contingent. The educational reinforcement is usually supplied with the aid of . . . Say 'X', where the listener, becoming a speaker, is reinforced if his response yields the sound pattern 'X' (1957, p. 56).

It is important to point out that syllabic units come under "echoic" control so that entirely new words may be quickly produced by the child when he "echoes" the syllables pronounced by the adult training him. The learning task which remains in this case only involves establishing a chain between the syllable responses which the child already has in his repertoire.

Speech Discrimination to Environmental Stimuli

In order to clearly present the different principles involved, the process of shaping correct speech was separated from the processes involved in the emission of the speech at the proper time and place; that is, the process whereby speech comes under the control of the appropriate environmental stimuli. In actuality, the child is involved in both types of learning simultaneously. He is trained to make "good" speech responses at the same time he is trained to make them only in certain circumstances. The principle involved is the discrimination of a speech response (Skinner, 1957).

When the child first says "daddy" or an approximation, the child's parents usually reinforce this response, whether or not the father is present, and whether or not the child is looking at the father. This experience strengthens the response, but in the presence of many different stimuli. Thus, the response does not occur in any specific situation. Once this speech response has been strengthened to the point where it occurs frequently, however, even to inappropriate stimuli, the discrimination training customarily starts. Only when the child says "daddy" in the presence of the father does reinforcement occur. The response is consequently extinguished in the presence of other adults and children.

At this point the response might not be precisely under the control of the appropriate stimulus. Although the child no longer says "daddy" in the presence of mother and does in the presence of the father, it might be found that he also says "daddy" in the presence of stimulus objects similar to father, for example, other males. A salesman calling in the afternoon, when father usually comes home, may be greeted by the child's response, "daddy." This is of course an illustration of the simple principle of stimulus generalization. However, since the child will not be reinforced for this generalized response, in due time his speech response will come under the precise control of the stimulus object, father. Skinner calls such a discriminated speech response a tact.

> A tact may be defined as a verbal operant in which a response of given form is evoked (or at least strengthened) by a particular object or event or property of an object or event. We account for the strength by showing that in the presence of the object or event a response of that form is characteristically reinforced in a given verbal community (1957, pp. 81-82).

After the child has acquired the basic sounds involved in English speech, and is able, within limits, to produce sounds which match (i.e., echo) those produced by someone else, repid speech vocabulary growth is possible. The mother can then simply present a new object and say its name, e.g., hold up a ball and say "ball." Reinforcement of the child's matching response while looking at the ball will establish the tact.

Numerous experiences of this type occur. When the child goes for an automobile ride with his parents, for a walk, to the store, and so on, there are occasions when the child looks at an object or event at the same time as the appropriate word is presented. The child is asked to repeat the word, and the response is then reinforced. The child learns in this manner to tact environmental events as well as objects. For example, in the presence of a moving automobile the child is told that it is moving. When the child says "moving" in the presence of something moving, he is reinforced. A moving object will thus become the discriminative stimulus for that speech response. If an automobile is also a discriminative stimulus for the response "automobile," then in the presence of a moving automobile the child will tend to emit the response, "automobile moving," or some such statement. The child will thus learn simple and complex speech responses to environmental events, both simple and complicated.

The learning of tacts is also carried on in great detail in ordinary language training. Although the child may first be reinforced for saying "automobile" in the presence of the total stimulus object, he will eventually be reinforced for emitting the appropriate speech responses to various parts of the object. Thus, detailed discrimination training involving particular aspects of the total stimulus situation is ordinarily conducted as is shown in the number of environmental events which control particular speech behaviors.

In addition to this type of discriminated verbal behavior, a child will ordinarily receive training in responding to internal stimuli such as aches and pains, to stimuli produced by his own behavior, and to other types of stimuli. Thus, many complex, detailed, and subtle stimulus events eventually come to control the appropriate complex speech responses.

The Acquisition of Reading Behavior

Texting

It is important that speech responses be brought under the control of appropriate external and internal stimuli. In addition, it is equally important that speech responses come under the control of appropriate visually presented verbal stimuli. In Skinner's terminology (1957) this is called texting. A textual response is a speech response that is under the control of the appropriate visually presented verbal stimulus. In everyday terms this is simply called reading.

Textual behavior is formed in a manner similar to that involved in learning a repertoire of speech responses to the other types of stimuli. Ordinarily, however, by the time training in textual behavior commences, the child has acquired the necessary speech responses. Thus, the child is able to match his speech responses to those given by the person guiding the instruction. A simple model for training a textual response is to present the written verbal stimulus to the child, say the word aloud, and have the child make a response which approximates the sound. For example, the word dog could be presented to the pupil, or group of pupils, and the teacher says "dog." The pupil responds by saying "dog" while looking at the word stimulus. Later, the stimulus word is again presented and the pupil will tend to say "dog" with no prompting. When the visually presented stimulus word elicits the appropriate speech response, the child is said to be able to read the word.

The verbal discriminations which must take place in the acquisition of reading are also very fine and detailed. For example, it will be found that a child who has come to respond to the stimulus the with the response "the" will also respond at first in the same manner to then, and perhaps to there, and so on. Since the stimuli are quite similar, stimulus generalization occurs. The same is true of such words as pat, sat, hat, fat, and so forth. Thus, a great deal of training is necessary to produce the correct discriminations.

Textual responses may be acquired in finer units than whole words either through the repeated experiences of the child in reading or through formal training. The units of which stimulus words are composed will come to control unitary speech responses of which word responses are composed. Accordingly, the child will come to emit the correct speech response in the presence of the syllabic units and single letters of which the words are composed. For example, when the stimuli p, s, h, and f have come to control the speech unit responses which produce the "p," "s," "h," and "f" sounds respectively, and if the stimulus at controls the speech response producing the "at" sound, then the discrimination between the verbal stimuli pat, sat, hat, and fat is complete.

When this type of discriminative control of textual behavior has been conditioned, the acquisition of speech responses under the control of novel stimulus words may take place. That is, the pupil becomes capable of learning a new textual response by responding successively to the letters and syllables of the stimulus word. The syllables will be "linked" so that the first elicits the second, and so on, in a manner which had not occurred before. The new word response would be under the control of the appropriate visual stimulus. Of course, if the word response was not one which the child had previously received training for emitting in appropriate circumstances, the simple establishment of the speech response controlled by a visual word stimulus would not effect its other language functions. The word response would not be under the control of other stimuli and would not, consequently, occur in appropriate circumstances, nor would such a word be meaningful.*

A Comparison Between Speech Development and Reading Acquisition

Interesting comparisons may be made between the learning of verbal responses to non-verbal stimuli and the learning of those same responses to visual verbal stimuli, that is, learning to read. It was said earlier that the same principles are involved in both types of learning. Both are essentially problems of establishing verbal responses under stimulus control. If that is the case, why then is reading behavior so much more difficult to acquire? Virtually every intact individual acquires adequate speech behaviors, yet there are many individuals who, although they display adequate vocal behaviors, are seemingly unable to learn to read, or do so only with great difficulty.

It is commonly suggested that such uneven development is a result of some biological defect, such as neurological impairment. However, unless there is some independent observation of a defect, this type of conclusion may simply be ad hoc. If the child is capable of acquiring differential speech responses to the ordinary visual stimuli in a normal manner, then it should be possible for visual verbal stimuli to also come to control the verbal responses. There is certainly no obvious difference in the stimuli themselves, since both are visual and both are complex. Ordinary language behavior requires that verbal responses be under the control of very subtle aspects of one's stimulus environment. The same thing is true of reading, i.e., the stimuli are no more complex.

On the other hand, on the basis of the present analysis, it would seem that there are some very real reasons, exclusive of personal defect, why some people do not learn to read even though their speech development is otherwise normal. Actually, for everyone, learning to read is accomplished only with great difficulty in comparison to the acquisition of speech under the control of other stimuli. To indicate the reasons, several important characteristics of the acquisition of speech responses, and the process whereby speech responses come under the control of external and internal stimuli should be emphasized.

First, as has been implicit in the previous discussion, the process of speech acquisition is very gradual. Beginning with the strengthening of the general speech class in early infancy, more and more precise speech responses are gradually shaped up until the exact word responses of the language community occur. These responses are only gradually brought under the control of the appropriate stimulus objects in a long program of training. Learning sessions occur intermittently and are dispersed throughout the day. In addition, new objects are introduced over a period of years in building up verbal discriminations.

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*These aspects of language learning are not considered in this study, but have been dealt with in other works (Staats, 1961; Staats and Staats, 1957; Staats and Staats, 1959; Staats, Staats and Heard, 1961).

Secondly, there are strong sources of reinforcement involved. When the child first says "wahtar" the strong reinforcer of a cup of water is presented. When the child says "baybee" the strong reinforcer of a baby doll is presented. In addition, strong reinforcers are abundantly available in the attention and approval of people in the environment. When the child says "look" and another child responds by looking, this is a reinforcer for the verbal response.

Thirdly, these strong reinforcers are individually applied, and they are applied immediately following the speech behaviors involved. As has been discussed, it is most important that the reinforcing stimulus be presented quickly after a response has occurred. If no reinforcer is presented, or if the lag is too great, the response will not be strengthened.

Intensity of Training in Reading

Comparing these characteristics with those involved in the acquisition of reading behavior, it becomes obvious that the learning of reading would be more difficult for everyone. Unlike speech behavior itself, and speech behavior under the control of other types of stimuli, reading is not gradually acquired in the pre-school years. It is customary to introduce training in the acquisition of speech responses to visually presented verbal stimuli only when the child enters school. Although there is some attempt to make this more gradual through the use of nursery schools, kindergartens, and reading readiness programs, in comparison to the learning of speech responses, the onset of reading training is sudden and intensive.

This major difference between speech and reading learning has important consequences. For example, intensive periods involving the acquisition, or the performance, of responses may be considered to have aversive characteristics. It has been shown that discriminative stimuli acquire aversive characteristics after an extended period of "working" in the presence of the stimuli, even when the responses involved are reinforced. That is, another response which will remove the discriminative stimulus will be maintained in some strength. Furthermore, the more intensive the "work" is (i.e., the greater the ratio of responses to reinforcement), the more aversive the discriminative stimulus becomes (Azrin, 1961).

Naturalistic observations also suggest that the intensive rather than gradual training of reading has aversive aspects. Many children describe school and school activities as "work," and in aversive terms. Although the language learning which takes place prior to school training is just as complex, and in these terms just as difficult to acquire, it is not described as being trying or difficult to the same extent as is formal training. The child does not say that he is having, or has had, a difficult time learning to speak--or learning his extensive repertoire of discriminated verbal operants.

In addition, to the extent that the school situation is aversive, it will be reinforcing to "escape" the situation. Any behavior which removes the child from the aversive situation will be strengthened. Thus, behaviors such as talking to other pupils, cutting up, doodling and playing quiet games, teasing other pupils, day-dreaming, etc., will be strengthened by providing an escape from the aversive training situation. Of course, it is possible to make the behavior of leaving the situation in these ways more aversive through punishment and, in this manner, maintain good participation in learning. Education in former times utilized these methods.

It would seem, then, that there might be two ways to deal with the problems introduced by such an intensive training program. First, it should be possible to reduce the aversive nature of the onset of formal training by having it introduced considerably more gradually. In addition, the introduction of positive reinforcers into such an intensive program would change the situation in the direction of making it more positively reinforcing. To some extent, both of these developments have occurred in American education. Nursery schools, kindergartens, and reading readiness programs do make the training somewhat more gradual. In addition, an attempt has been made to make learning more game-like, life-like, or "interesting" (i.e., reinforcing) and less work-like (i.e., aversive). These methods have sometimes been identified by the term "progressive" education. Unfortunately, however, it is well established that the acquisition of reading still forms a problem of training; the corrective measures taken thus far have not been adequate.

Sources of Reinforcement for Reading in the School Situation

A closer look at some of the sources of reinforcement available in the early school situation will indicate some of the remaining difficulties. To an extent dependent upon the child's past history, the acquisition of a new behavior (i.e., learning) may become reinforcing itself. That is, the stimuli produced by studying something and acquiring new "knowledge" (verbal behaviors) or "skills" (motor behaviors) will become secondary reinforcers if positive reinforcers have been frequently paired with them in the past. It is traditionally assumed that this type of reinforcement should be present for all students, witness the old saw, "Learning is (or should be) its own reward." Again, however, this cannot be counted upon. Many children do not have a past history which has made learning itself reinforcing. When this is the case, it is ineffective to simply invoke the plea that learning should be reinforcing.

The same thing occurs in making educators and their approval secondary reinforcers. For some children the teacher's attention and approval are strong reinforcing stimuli. Since these are learned reinforcers, the extent to which they function as reinforcers will depend upon the past history of the child. If the child comes from a home which has not paired learning with reinforcing stimuli, where education and educators have not become secondary reinforcers, he would be said to have little "value" for education. The teacher's approval would have scant reinforcing properties in such a case. Unfortunately, many children would be expected to have ineffective histories in this respect.

In addition to the inadequacy of the teacher's approval as a positive reinforcer for some children, there are other restrictions upon the effectiveness of this source of reinforcement. In the school situation, reading training involves a group of children. To a large extent, this makes impossible the presentation of the reinforcement immediately contingent upon the behavior of the individual child. Only when the child recites individually may his behavior be immediately reinforced by other persons, and, of course, only a small proportion of school time will be occupied with the behavior of any one child. Much of the work takes place in group study or group recital where no extrinsic reinforcement is involved.

There are other reinforcers in the school program such as grades, special privileges, games, recesses, and the approval of other students. In kindergarten the children are provided with toys, snacks, rest periods, television, and so on. These stimuli undoubtedly act as reinforcers for some children. However, these reinforcers are seldom presented contingent upon correct reading behavior, and even when contingent they are not immediately delivered. In addition, most of the available reinforcing stimuli are heavy-weight reinforcers which are delivered all at one time, whereas the behavior involved consists of numerous responses, a good proportion of which should be individually reinforced.

The reinforcers available in the school situation may vary from child to child. And, for some children there may be only weak reinforcers which are made contingent upon his reading behavior. In addition, there is a "snowballing" effect, since the child for whom there are only weak reinforcers in the school situation learns to read very slowly. Because he accomplishes little he receives less reinforcement contingent upon his classroom performance, and his behavior becomes relatively weaker. It may be concluded that, as compared to speech learning in everyday life, learning to read occurs in a situation much less favorable in terms of the application of reinforcement principles. It would thus be expected that many failures would occur in the development of this vital repertoire of behaviors.

One final point. If positive reinforcers available in the school situation are weak or ineffectively applied, then the behaviors which are prerequisites to the acquisition of reading will not be maintained. To acquire reading behavior the child must first respond by looking at the words and letters and then by making the appropriate verbal responses to the prompts of the teacher. If these prerequisite behaviors, which in everyday terms are called the attention of the child, are extinguished through lack of sufficient reinforcement, then further progress in learning to read ceases. Such a child would not acquire proper reading behavior even though present in class during appropriate training. It would certainly be erroneous to conclude in such a case that the child had some physical defect.

A summary of the important points involved in this section might be as follows. First, the onset of an intensive training program in reading is relatively sudden and may involve a good deal of aversiveness. In addition, there are only weak sources of reinforcement for many children in the training situation. Furthermore, the reinforcers which are available are not made immediately contingent upon the many "reading responses" involved. Finally, if adequate reinforcement for the child is not available in the reading program, the behaviors which are prerequisites for the acquisition of reading may extinguish. If this happens, progress in learning to read will cease.

Implications for Research

It becomes evident from this comparison that there are important implications for understanding some of the special problems encountered in learning to read, and for conducting research on reading acquisition. Although it is not within the scope of this paper to outline a research program based upon the present analysis, a few examples can be given to indicate the type of research which might be derived.

The rationale which suggests applications to a study of reading can be stated in the following points:

(1) If the prerequisite behaviors of attending to and working at the acquisition of speech responses to visual verbal stimuli are not reinforced they will extinguish;

(2) The more intensive the training, the more aversive such training becomes;

(3) This aversiveness will act as a strong negative reinforcer and incompatible behaviors which remove the child from the aversive situation (absenteeism, cutting up, daydreaming, etc.) will increase in frequency;

(4) The use of positive reinforcers, immediately contingent upon the prerequisite behaviors involved in the acquisition of reading could prevent the extinction of these behaviors, and prevent or reverse the learning of incompatible behaviors;

(5) Reinforcement of reading would also make this behavior itself become positively reinforcing;

(6) As a consequence of the use of reinforcement for reading, very rapid learning should occur.

These points strongly suggest that reading learning should be studied in a procedure involving the immediate application of positive reinforcers for attending to and working at the acquisition of textual responses. Experimenters are already studying the possibilities of shaping simple behaviors in children through the use of various reinforcers (Bijou and Sturges, 1959). Trinkets, tokens, money of small value, toys, music, snacks, approval, and so forth, have been used in various combinations. The results indicate that the principles discussed herein are applicable to the training of children, and therefore they should be applicable to the significant area of reading.

From such study the basic principles involved in learning to read could be determined and the information obtained would be important for application to the establishment of future training programs. Such research would be a direct outgrowth of this type of analysis concerning the application of behavior principles to the area of reading development.

Further study must be made of the possible use of existing sources of reinforcement. The snacks, toys, recesses, etc. usual in the kindergarten are strong reinforcers, but they are not made specifically contingent upon the behavior which is to be developed. This might be possible, however, through the use of a token system where the token was made contingent upon the behavior to be strengthened. The tokens could be established as secondary reinforcers by being paired with the reinforcers already available in the situation.

It may be said that there are practical restrictions involved in the use of individually applied reinforcers in a teaching situation. Teacher time in a more individualized program might be excessive. In addition, some people might oppose the use of extrinsic reinforcers in the training of children. However, a priori judgments such as these are not justified. Before practical circumstances can be adequately evaluated, it is necessary to understand the principles of behavior which are involved in language learning, and to have empirical results upon which to make decisions.

Actually, these types of objections may prove to be unwarranted once a program of the type described has been developed for reading training. For example, it might be possible to mechanize the training program, including the delivery of reinforcers. Recent successes with automated teaching devices, even without the use of extrinsic reinforcers, indicate this as a likely possibility (Holland, 1960).

In addition, with the rapid learning which the use of reinforcement would promote, perhaps only a short program would need to be involved until the appropriate reading units are acquired. That is, perhaps an intensive program of reinforcement is necessary only until units of verbal responses (e.g., syllable and letter responses) come under the control of appropriate visual stimuli. Once this has occurred the child will be able to read many different words the first time they are presented and less supervision would be necessary for further progress. Thus, it might be more effective to spend time with the individual child in the early phases of reading training, than to prolong less effective training which proceeds slowly and produces many failures. Only research of the suggested type will provide this information.

Along this line, it should be pointed out that learning the initial behaviors involved in reading has intrinsic value only if the child has been trained in such a manner that learning is reinforcing. Otherwise, acquiring reading responses involves a great deal of effort or "work," i.e., it is not reinforcing. Once the unit speech responses have been well acquired, however, the same amount of work is not involved. Then reading has the same reinforcing value as being told a story. At this point it would not be necessary to continue the frequent extrinsic reinforcement of reading behaviors. (A more detailed analysis of this rationale is available, but is not presented at this time.)

It is also possible that a one-to-one ratio of student to teacher using a program including extrinsic reinforcers would be appropriate for working with special populations of children, e.g., retarded children, deaf or blind children, remedial readers, etc. Learning here could be strongly accelerated and make the one-to-one relationship practical, especially since the type of program which may emerge would not require highly trained individuals as administrators. It would be expected that the program would be especially pertinent for retarded children, since much of their learning problem probably involves the weak and slow learning of secondary reinforcers.

These are all issues which can only be resolved by conducting appropriate research. An understanding of the behavior principles involved in language learning indicates what some of the lines of research should be. Through this type of analysis and research it is hoped that the findings of general psychology and the practical problems of child development and education can be brought into a useful relationship.

III. Study IV. The Effects of Discrimination Pretraining on Textual Behavior*

Carolyn K. Staats, Arthur W. Staats, and Richard E. Schutz

Muehl (1960) has investigated the effects of different types of visual discrimination pretraining on the performance of kindergarten children in learning to read a vocabulary list. He found that children who received pretraining in matching the same words that appeared in a later vocabulary list learned to "read" the words significantly better than children who received similar pretraining with different words or with geometric forms.

Muehl suggests that is was the response to single letters or details of letters that appeared to account for his finding. He hypothesizes that "positive transfer to the learning task...was due to the acquisition, during pretraining, of a set of observing responses to distinctive letters in the stimulus words."

The present study extends the stimulus pretraining research by comparing pretraining experiences. Prior to learning the same vocabulary list, kindergarten children were exposed to one of three conditions: (a) discrimination pretraining with the same words as those appearing in the vocabulary list, (b) discrimination pretraining with the letters making up the words in the vocabulary list, and (c) no discrimination training.

Based upon the hypothesis that if differences are established among similar stimulus elements, then learning will be facilitated in a subsequent task using these same stimuli, it would be predicted that no significant difference in learning the vocabulary list would be found between the group given visual discrimination pretraining on the same words and the group receiving visual discrimination pretraining on the letters in the words. Both these groups would be expected to learn the vocabulary list faster than the group given no discrimination pretraining. On the other hand, if the requisite condition for facilitation of learning is discrimination pretraining on the same stimuli, it would be predicted that the group given training on the same words would learn the vocabulary list faster than either of the other two groups.

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Another line of theory and research also contributes to the present study. Skinner (1957) introduced the term "textual response" to refer to an operant vocal response under the control of nonauditory verbal stimuli, i.e., printed symbols. It is suggested that this term should replace the phrase "reading aloud" because the complicated connotations of the verb "to read" are often misleading. Questions of "comprehension" or "understanding" or "meaning" frequently become spuriously intertwined with research aimed at understanding the variables involved in learning to make the appropriate vocal response to the printed verbal stimulus. Although a full analysis of reading must include the principles of classical conditioning and the interaction of classical and operant principles in the development of word meaning (Staats, 1961, Staats and Staats, 1957), the use of the term texting concerns only the operant conditioning of a vocal response under the control of a visual verbal stimulus. The present study utilized these principles in two ways: discrimination pretraining was programed (the discrimination progressing in difficulty through the training with little opportunity for failures); and reinforcement was made contingent upon the emission of correct vocal operants in both discrimination and texting training.

Method

The procedure was composed of three parts: familiarization training which was uniform for all subjects, discrimination pretraining which differed for each group, and criterion texting which was the same for all subjects.

Subjects

The subjects were 36 children from two kindergartens in Tempe, Arizona. Shortly prior to the experiment the Columbia Mental Maturity Scale was administered to all subjects. The children were then matched on MA and assigned to one of the three pretraining groups. There were 12 children in each group. Table 1 shows the mean ages and MAs in each group. In all phases subjects worked individually with one of two adult male experimenters.

Familiarization Training

The following procedure was used to acquaint the subjects with the token reinforcement system and to train them in the responses required for the discrimination task. To establish the tokens as reinforcers, the subject was given four or five token plastic discs and allowed to choose and buy a toy (plastic trinket). This was done twice for each subject. The training for the discrimination task involved the following: Subjects were shown 10 cards consecutively, each containing three stimulus components (geometric figures, drawings of common objects, or combinations of letters printed upside down), two of which were the same and one different. The first five cards were simply 5 x 8 replications of the first five items of the Columbia Mental Maturity Scale with which the children were already familiar because of prior testing. The subject was instructed.

TABLE 1

Means and SDs of Mental and Chronological Age in Months

	Group I		Group II		Group III	
	M	SD	M	SD	M	SD
Mental age	65.9	7.07	65.8	5.29	65.4	4.90
Chronological age	67.0	2.64	64.7	1.73	66.9	3.32

"Point to the one that doesn't belong." If the subject responded correctly, he was given a token, while if the response was incorrect or if the subject failed to respond in 5 seconds, the experimenter withheld the token reinforcer and presented the next card. At the end of the series, the tokens were once again exchanged for toys.

Discrimination Pretraining

The two different sets of stimuli used in the pretraining phase each consisted of 48 additional cards of the same type of task as that used in the familiarization training. Reinforcement in the form of tokens, later exchanged for toys, was again made contingent upon the correct response.

For Group I the discriminative stimuli consisted of words printed in lower-case type which were later used in the texting task. Twenty-four cards were made up of combinations of the four-letter words: *door*, *bell*, *fish*, *kite*. One of these four appeared twice, another appeared once on the card, and the subject's task was to "point to the one that doesn't belong." Every word was paired with each of the other three in this series from one to three times. The remaining 24 cards each contained one of the same four-letter words paired once with other four-letter words not included in the texting task. Of these 24, eight discriminations involved words with all four letters differing, eight with three letter differences, and eight with two letter differences. The combined 48 cards were then arranged progressively as to difficulty of the discrimination, e.g., *fish* and *door* appeared on a card early in the program, while *fish* and *film* were paired on Card 47. The position of the correct alternative on the card was varied across the series of 48 cards to prevent a position preference.

For Group II the 12 lower case letters *b*, *d*, *e*, *f*, *h*, *i*, *k*, *l*, *o*, *r*, *s*, and *t*, which comprise the words *door*, *bell*, *fish*, and *kite*, were presented individually rather than the words themselves. Along with each single letter another letter, randomly selected from the same list of 12 letters, appeared twice. Each of the 12 letters in the list appeared as a correct alternative on four occasions, except for *e* which occurred five times, and *k* which was presented three times. These cards were then arranged progressively as to difficulty of discrimination, e.g., Card 1 was *k k o*, while Card 42 was *e o e*. For the series of 48 cards the location of a correct letter was varied so as to avoid a position preference. The subject's task was again to "point to the one that doesn't belong."

In both these groups, tokens were exchanged for toys subsequent to Trials 8, 16, 32, and 48.

Group III received no discrimination training other than that implicit in the familiarization training.

Texting Task

Immediately following the pretraining discrimination task, the same texting task was administered to all subjects. This criterion texting consisted of 12 presentations of each of the four words presented to Group I in the discrimination training (*door*, *bell*, *fish*, *kite*). These words were organized into six blocks, each block consisting of two presentations of each of the four words; the order of the words within each block was randomized. Each block was then divided into two trials of four words each. This yielded 12 trials in all.

Responses on the first trial (Cards 1 - 4) were pointing to the word as the experimenter said the word, and for the second trial (Cards 5 - 8) the subject was to point to the word and repeat the word aloud (an "echoic" response). Since these two trials permitted no variability among subjects, the first block (Cards 1 - 8) is not included in the analysis.

The final 10 trials (or five blocks) constituted the criterion task. The subject was instructed by the experimenter to "say the word before I say it," constituting a paired-associate method of presentation. The experimenter presented the stimulus card, and then waited approximately 2 seconds for the subject to say the word. Correct responses were reinforced as before, and incorrect responses were prompted but not reinforced. Tokens were exchanged for trinkets at the end of Trials 7 and 12. The entire experimental procedure was conducted in a small room close to the subject's own classroom.

Results

Learning curves depicting the number of correct anticipations occurring in the texting task for each of the pretraining groups are presented in Figure 1. A Bartlett's test (Lindquist, 1953) showed that the variance in the number of correct responses in the three groups was homogeneous. A summary of the analysis of variance (Lindquist, 1953, Type I) for these data is given in Table 2. The F of 6.77 ($p < .01$) for Trials shows that significant learning occurred in the course of the texting training over the three groups. The F of 1.42 for Groups indicates that the type of discrimination pretraining did not significantly affect texting performance.

Edwards (1960, p. 136) points out, however, that "in making multiple comparisons among treatment means, it is not necessary that the treatment mean square of the analysis of variance be significant." He suggests that the choice of multiple comparison method should be guided by questions of experimental interest. According to this rationale, and because of the discrepancy of the results of the analysis of variance with Muehl's findings, it was considered appropriate to further compare the means of the pretraining groups with the Duncan new multiple range test. This test indicated that there were significant differences ($p < .05$) between the mean of Group I and the means of Groups II and III. The difference between the means of Groups II and III was not significant. Inspection of Figure 1 also indicates that the difference between Group I and the other groups was evident by the first block included in the analysis. The mean number of correct responses for Group I was 3.25 in the first

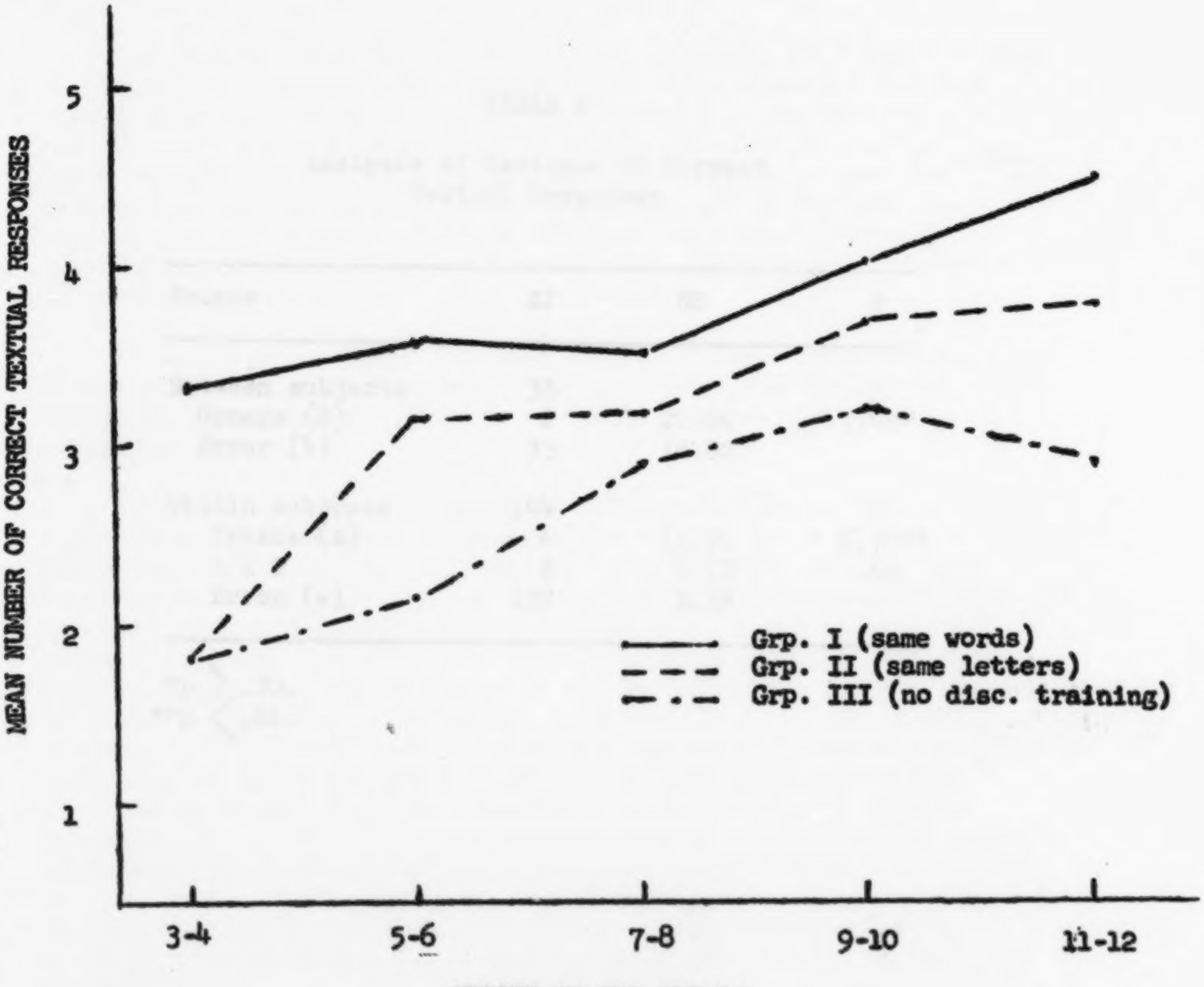

Fig. 1. The effect of type of discrimination pretraining on correct textual responses in learning the criterion task. (Eight responses were possible in each block of two trials.)

TABLE 2

Analysis of Variance of Correct Textual Responses

Source	df	MS	F
Between subjects	35		
Groups (B)	2	21.06	1.42*
Error (b)	33	14.82	
Within subjects	144		
Trials (A)	4	11.71	6.77**
A x B	8	1.17	.64
Error (w)	132	1.73	

*$p > .20$.
**$p < .01$.

block in each of the other two groups was 1.83.

Correlations were also obtained among the MA scores on the Columbia Mental Maturity Scale, the performance on the discrimination task, and performance on the texting task. None of the three correlation coefficients was significant.

Discussion

The results tend to corroborate the findings of Muehl and other investigators (Kurtz, 1955; Spiker, 1956) that stimulus discrimination pretraining results in positive transfer to a later task when the same stimuli are presented in that task. The interpretation that these results are due to acquisition of an observing response to the distinctive letters making up the words was not supported since no significant difference was found between the group receiving pretraining on letters making up the words and the group receiving no pretraining at all.

It would seem, then, that the word functioned as a unique stimulus in the discrimination training. Whatever the nature of the observing response, it was made to the entire word, a complex unitary stimulus.

However, the results cannot be interpreted as indicating that alphabetical pretraining in general has little or no effect in enhancing later texting performance. The subjects used in this experiment had not learned the letter names. Subjects were deliberately selected from a population which had not had "alphabet training" in order to isolate the effect of simple discrimination pretraining, and to insure that the response of naming would not mediate the acquisition of textual responses. It may be, however, that texting pretraining on alphabetical units of words, including the development of some phonetic responses to these units would prove the most efficacious type of pretraining in the applied situation. Thus, while the results question the relevance of pure discrimination pretraining on alphabet components of words in facilitating later texting behavior, it may be that texting training on these units would prove valuable for transfer to the whole word. Further research relating texting of letter units to the later texting of entire words thus would appear to be fruitful.

Another reason for questioning the efficacy of pure discrimination pretraining for the later texting behavior is the wide variability in the texting performance of subjects in the same group shown in Table 2. Since these variances were homogeneous, the size of the MS for between subjects in the same group may be interpreted as indicating the large differences among individuals were maintained in spite of constant experimental treatment. Thus, even though the results of Group I were, overall, superior to the other groups, large differences in the criterion texting are all attributable to other unknown variables. Even the use of programed discrimination training did not suffice to bring the children to a common starting level.

Finally, the lack of a significant correlation between discrimination and texting behavior indicates that better discrimination performers were not better learners of texting. This indicates that the same behaviors were not involved in the two tasks and that the acquisition of texting does not depend solely on the previous acquisition of observing responses.

The lack of significant relationship between the pretest performance, i.e., the Columbia Mental Maturity Scale and the other two variables, also suggests that different variables are involved in performance of these tasks. The use of these types of tests for predicting early reading behavior thus seems questionable.

IVB Study III. The Conditioning of Textual Responses Using "Extrinsic" Reinforcers*

Arthur W. Staats, Carolyn K. Staats, Richard E. Schutz,
and Montrose Wolf

In the extension of operant-conditioning principles to teaching devices, little systematic work has been concerned with the nature of the potential reinforcers. Porter, in reviewing the literature on teaching devices, indicates that exploratory and manipulative activities have been suggested as reinforcers but that these weaken through satiation. He comments that alternative reinforcers could be used. Skinner has mentioned social reinforcers, desired activities, and aversive stimulation; and Pressey has indirectly suggested candy. Porter concludes "Most authors of articles concerning immediate reinforcer teaching devices are content, however, to side-step the problem of what reinforcers to use" (1957, p. 135).

More recently, however, Holland has stated that "With humans, simply being correct is sufficient reinforcement" (1960, p. 278). The statement that being "correct" is positively reinforcing could stand closer scrutiny. The observables which define "correctness" are that the response of the subject produces some record, a stimulus, which matches the stimulus of the "answer" to the item.

Ferster (1960) has shown that pigeons can be conditioned to peck a key that matches (in light value) another key. This type of training would be expected to make the matching stimuli conditioned reinforcers as well as S^D's. Therefore, it should be possible to use two stimuli which are variable so that a matching of the two would be the S^D and a miss-match the S^{Δ}. Later, the organism could be conditioned to vary a manipulandum which would adjust the two stimuli, simply on the basis of the reinforcing value of the match.

On the basis of this type of training, matched stimuli would become a reinforcer for a child. Withholding reinforcement until

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*This study has been published in *Journal of the Experimental Analysis of Behavior*, 1962, 5, 33 - 40.

the child more closely echoed an adult's verbal behavior would constitute an example of such training. Normally, a child would have experienced many trials in which he was reinforced when his response matched a stimulus produced by an "authority" source, and when non-matches were not reinforced.

On the other hand, as with other types of experience, individuals would probably differ widely in the amount of this training received. These differences should determine the extent to which "matching" would be reinforcing--an important source of reinforcement in the school situation. This is not the place for a full discussion of this effect; however, the younger the child, the fewer matching conditioning trials he would be expected to have received. In addition, special populations such as mental retardates or lower-class children would be expected to be weakly trained in this manner. Being "correct" would thus be expected to be a weak (if not absent) reinforcer for many people, and especially for very young children in their first learning tasks.

In addition to this source of reinforcement, a "correct" response allows the subject to continue to the next item--thus making a match reinforcing. However, whether or not, or to what extent, such "achievement" will be reinforcing will also be determined by the individual's past history of reinforcement.

Consequently, it seems wise not to depend entirely on the development of teaching techniques which involve only the reinforcement of being "correct" or "moving on," at least for some learning tasks. The present study begins the exploration of the development of textual behavior using additional reinforcers. In doing so, the effect of the reinforcers is established, and a short texting program and experimental procedures are developed with which to conduct further studies. In this stage of the research, the emphasis is less upon mechanizing the program than upon the study of the reinforcers, procedures, the response units, and the program.

Method

Subjects

The six 4-year-old Ss (five boys, one girl) were children accepted for the next year's (1961) fall semester of kindergarten at the Arizona State University Laboratory School. A female graduate assistant transported the Ss from home to the Arizona State University Psychology Department laboratory and back again. Participation in the experiment was entirely voluntary and could be terminated at any time.

Reinforcers

A large variety of reinforcers were used, such as trinkets, edibles, and tokens. The trinkets were plastic rings and puzzles, toys manufactured for vending machines by the Paul A. Price Co. of New York, and occasional balloons and pennies. Examples of edibles were M and M's, raisins, animal cookies, cereal, and peanuts. The tokens were small, red, plastic discs which were placed in a token board containing 24 appropriate holes. When an *S* filled the board, he was given a "secret surprise," previously hidden under a black metal box. Secret surprises were predominantly Miniature Brand products such as miniature Band-Aids, Alcoa Aluminum Wrap, and Scotch Tape, as well as plastic cars, plastic soldiers, and miniature tools from the variety store. The trinkets, edibles, and tokens were given in approximately equal numbers. Each *S* earned about 100 reinforcers per experimental session, and gathered them into a plastic bag as he received them.

Experimental Conditions

The experimental conditions, each involving three *Ss*, were formed to present these reinforcers. Under one condition (No Reinforcement--Reinforcement), none of the reinforcers was given in the experiment until *S* requested that the activity be terminated, at which time the delivery of a reinforcer was made contingent upon each correct "reading response." Under the second condition (Reinforcement -- No Reinforcement -- Reinforcement), *Ss* were reinforced for each correct "reading response" during the first and second experimental sessions. Reinforcement was then no longer given until *S* requested that the activity terminate; at this time, the reinforcement procedure was reinstated.

Apparatus

A Universal Feeder housed in an enclosure and controlled by a foot-operated microswitch was used to deliver the reinforcers. The *S* sat at a low 2.5- by 4-ft. table with the Universal Feeder at his left and *E* at his right.

Materials

Program Stimuli. The 27 words of the program which were typed (primary type) on 22 5- by 8-in. cards are listed in the order in which they were introduced: the *S*'s first name, *the monkey*, *the candy*, *likes*, *ice cream*, *look at*, *brown*, *is*, *the elephant*, *the lion*, *has*, *a tail*, *gray*, *circus*, *the clown*, *red*, *and*, *blue*, *the drum*, *the horn*, *the boy*, *the girl*. The program started with the presentation of the first 4 cards of these 22. When textual responses had been established to the 5 words of these 4 cards, the words were combined, in various meaningful permutations, into sentences. Thus, when *S* had acquired individual texts to *S*'s name, *the monkey*, *the candy*, and *likes*, the following sentences were introduced: *Matthew* (for example) *likes the monkey*; *the monkey likes Matthew*; *the monkey likes candy*; and *Matthew likes candy*.

Thereafter, one new card of the 22 was introduced at a time and used in sentences of this sort as soon as the appropriate textual response had been established. As more word and sentence cards were introduced, *S* continued to be presented with the already learned words and sentences as well, mixed together.

When the first 11 texts as well as the various sentences composed of these words had been acquired, some of the sentences were combined into the following story which was presented on an 8.5- by 11-in. sheet of paper.

the monkey
look at Matthew.
look at the monkey.
the monkey likes candy.
Matthew likes candy.
the monkey likes ice cream.
ice cream is brown.
the monkey is brown.

In the program, new verbal stimuli continued to be introduced and combined into sentences. The sentences were combined into two stories in addition to the one shown. The second story contained 7 new words, 36 words in all, and 9 lines; the third story contained 9 new words, 83 words in all, and 16 lines.

Picture Board. The picture board was an 8- by 12-in. cardboard, which included a small picture of each of the verbal stimuli that could be pictorialized.

Word Board. The word board for each *S* consisted of an 8- by 10-in. cardboard with the verbal stimuli *look at*, *is*, *the monkey*, *likes*, *candy*, *ice cream*, *brown*, as well as *S*'s name, arranged in three rows of three words, with a small picture of a common animal substituted for the word in the bottom row of the middle column. The *S*'s name was in the top left position of the word board. Used with the word board were nine 5- by 8-in. cards, each containing one of the eight words or the picture.

Discrimination Cards. The verbal stimuli *likes*, *has*, *and*, *look at*, *is*, and *the* that cannot be pictorialized were placed in two rows of three words on each of six 5- by 8-in. cards, with the words occupying different positions on each card.

Procedure

The children were brought into the experimental room and told, "We are going to look at some pictures and read some words."

Picture Matching. The *S* was shown the picture board and a picture of a candy cane on a 5- by 8-in. card identical to the picture board. Then the *S* was told, "This is a picture of some candy. Can you find the other picture of candy here?" (The picture board was indicated.) If *S* was under the reinforcement condition in this example, as well as those to follow, a reinforcer was delivered contingent upon the appropriate response; if he was under the no-reinforcement condition, a social reinforcer was given, e.g., "all right," "good," "fine." Approximately 8 pictures were presented in this manner unless matching behavior was poor; if so, all 16 were presented.

Word Matching. Next, *S* was shown the word board which had *S*'s name in the top-left position and the 5- by 8-in. card containing his name. The *S* was instructed, as an example, "This is the word 'Matthew.' Can you find the other word like it here?" (The word board was indicated.) Approximately six such discriminations were presented unless more were required to shape a stronger matching response.

Texting Procedure. The *S* was again presented with the picture board and told that he was now going to learn some words. His name was then presented, and *E* said, for example, "This is the word 'Matthew.' Can you read this word for me?" Next, a card with *the monkey* was shown to *S*, and he was told "These are the words 'the monkey.' Can you find the picture of the monkey? (The picture board was indicated.) The two cards, i.e., *Matthew* and *the monkey* were alternated in a fairly random sequence until the discriminations were made. At that point, the stimulus *the candy* was presented, with the picture board; and then the card with this verbal stimulus was alternated with the two preceding verbal stimulus cards.

The fourth card was *likes*, for which there was no pictorial prompt, so the discrimination card procedure was used. The *S* was first shown the stimulus card with just *likes* on it and told "This is the word 'likes.'" Then a discrimination card was presented which included *likes* as one of its six words, and *S* was asked to "point to and read for me the word 'likes.'" The other five discrimination cards were then presented, and each time *S* was to point to *likes* on the card and pronounce the word. Then the card with the single word *likes* was again presented and *E* said "Can you read this word for me? What is this word?" If the correct textual response was not made, the discrimination "loop" was presented again.

After discriminations had been made for the first five words, the relevant sentences were introduced. Other words and sentences were then progressively introduced. The various words and sentences already learned were then continually mixed in with the ones *S* was presently acquiring. When *S* could text the sentences for the first 11 words, he was presented with some of these sentences in story form. The progression in the program was thus from single texts to sentences to stories; but these were gradually introduced and repeated.

When an error was made in a sentence, *E* orally prompted *S*. After *S* completed the sentence, however, *E* required *S* to repeat the whole sentence. If the error was made again, the individual verbal stimulus concerned would be presented in the procedure involving a discrimination loop or the picture prompt, depending upon the verbal stimulus. This procedure would be repeatedly brought into the program until the proper textual discrimination was made. Repetition of various parts of the program occurred frequently whenever behavior was weakly controlled by a word or words.

Under the reinforcement condition, reinforcers were given for picture-matching responses, word-matching responses, appropriate echoic responses when *E* orally prompted *S* on a word, discriminations in the discrimination loops, as well as for textual responses. When a sentence was presented, reinforcement was not contingent upon individual word responses, but only on the complete sentence "response." Sentence responses were also reinforced when *S* texted a story.

Experimental Sessions

Each *S* participated in eight 45-min. sessions, divided into two 20-min. periods separated by a 5-min. break during which *S* could get a drink, rest, look out a window, or ride a rocking horse. The *S*s also returned for a ninth session, but only for a test on some of the texts they had acquired.

At the end of each session, *S*s were asked if they wished to return again. If the *S* showed signs of displeasure during a session, he was asked if he wanted to continue.

Results

At the beginning of the second session and at the beginning of every session thereafter, *S* was given a test consisting of an unaided identification of the new words with which he had been presented during the previous session, and the older words which he had as yet failed to text correctly during the previous test sessions. The response unit was a correct text, and these units were cumulatively plotted. The response measure was thus not of the "reading" responses made in the conditioning procedure, but of the texts formed as a result of this training.

The abscissa used in the cumulative curves is not a continuous time measure; each unit on the abscissa represents one training period. The cumulative curve, consequently, does not indicate a rate of response during the conditioning procedure itself. Rather, it indicates the number of textual responses formed per training period. In this sense the curves may be considered as analogous to a rate, the rate of acquisition of texts per training period.

The results of the study are of two types: those concerning the "cumulative curves" established on the basis of the acquisition of the texts, and the various other observations of *S*'s behavior. These observations indicated that the experimental situation contained a number of response alternatives which can be discussed in two general categories: (1) behaviors which escaped the task, as for example, moving around the room, requesting to go home, and asking *E* irrelevant questions; and (2) the "reading behavior," as for example, looking at the visual verbal stimuli, looking at the pictorial prompts, and echoing *E*'s auditory prompts. The experimental manipulation of the reinforcers, contingent upon the "reading behavior," effected the relative strengths of these two types of behavior in all *S*s.

Figure 2 presents the data for the No Reinforcement--Reinforcement *S*s. Each record presents the data for a single *S* and is identified by *S*'s initials.

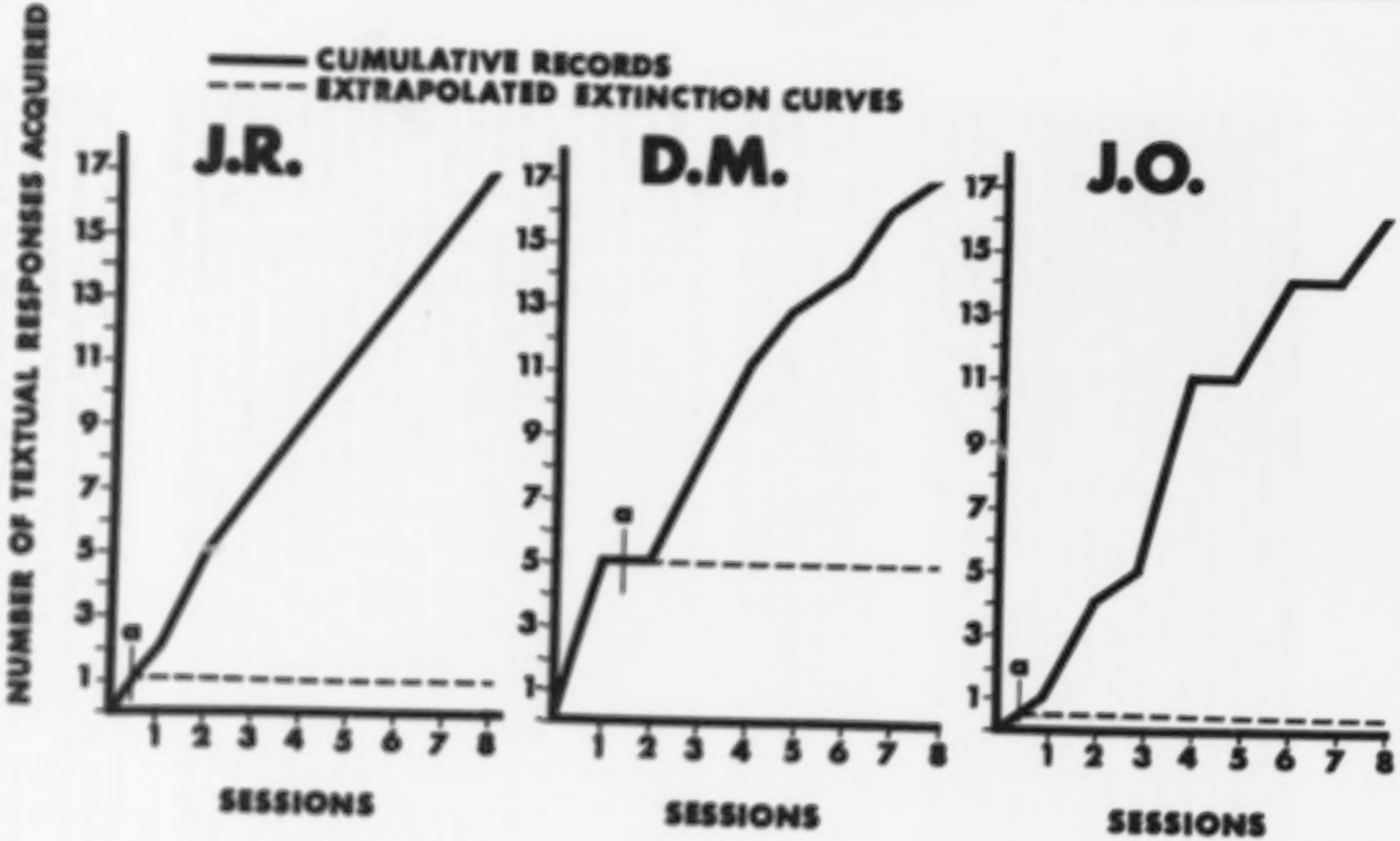

Fig. 2. The curves shown here were generated under a beginning period of no "extrinsic" reinforcement. When S would no longer remain in the experimental situation, reinforcement was instated as indicated by the mark on the curve. The dotted line commences at the point S would no longer remain in the experiment, and indicates the curve which would have resulted if reinforcement was not introduced.

As the curves indicate, without reinforcement the acquisition of texts does not commence, or it quickly ceases. That is, the program and the experimental situation without the added reinforcers seemed to have little reinforcing value, and they soon became aversive. Observation indicated that escape behaviors began to occur in the first session for all *S*s, and two of them requested to leave within 20 min. The dotted line on the curve commences at this point and indicates what the curve would have been without reinforcement. The other *S* emitted the same escape behavior in the first 15 min. of the second session, as the dotted line shows. When the "extrinsic" reinforcers were introduced, however, the escape behavior largely disappeared; working behavior returned in good strength; and participation became enthusiastic. This was reflected in the textual acquisition curves. Under the influence of the reinforcers, the reading behavior in the situation was maintained in good strength for the eight sessions, although DM again began to evidence some escape behaviors toward the end of the program.

The *S*s acquired totals of 16, 17, and 17 texts, tested out of context. Thus, the operant-conditioning procedures, in these few sessions, proved to be very successful compared with the reading achievement which these *S*s would make in their *next* year's work in kindergarten. The length of time these young children worked at a task ("attention-span") was directly a function of the reinforcing properties of the situation.

Figure 3 presents the data for the Reinforcement--No Reinforcement--Reinforcement *S*s. In general, this experimental condition produced characteristic curves. The reading behavior, when reinforced, was quickly brought under experimental control with enthusiastic participation. When reinforcement was discontinued, both the reading behavior in the situation as well as the acquisition of texts soon began to weaken. Eventually, other incompatible behaviors (escape behaviors) became more frequent in the situation; and, finally, behaviors occurred which would have terminated the activity. Subject DL told his parents he did not wish to continue the activity, and *E* was told that DL's sixth session was to be the last. Reinforcement was reinstated at this time, and reading behavior in the situation was strengthened. However, DL had arranged to terminate and other evidence indicated that reneging would have been aversive; therefore, his curve of textual acquisition ceases at this point. Subject MR's mother called prior to the seventh session to say *S* was terminating; but on *E*'s statement that reinforcement would again be available, *S* returned to the experiment and reinforcement was effective in strengthening the reading behavior. (The dotted line on the curve indicates what would have occurred without reinstatement of reinforcement for this and the next *S*.) Subject MJ stated he would not read any more during the sixth session, but reinstatement of reinforcement was effective in strengthening the reading behavior.

Thus, in general, reinstatement of reinforcement strengthened the behavior of reading and staying in the situation (with one exception), and resulted in the return of textual acquisition. However, the effects of the No-Reinforcement treatment continued to operate for a time. The *S*s' working behavior after the reinstatement did not attain its prior strength, nor was it as good as the behavior of the *S*s in the other experimental condition after their short period of No-Reinforcement. Thus, a child with a history of no reinforcement for reading behavior (a "non-reader") should be more difficult to train than a child who is just commencing his reading training.

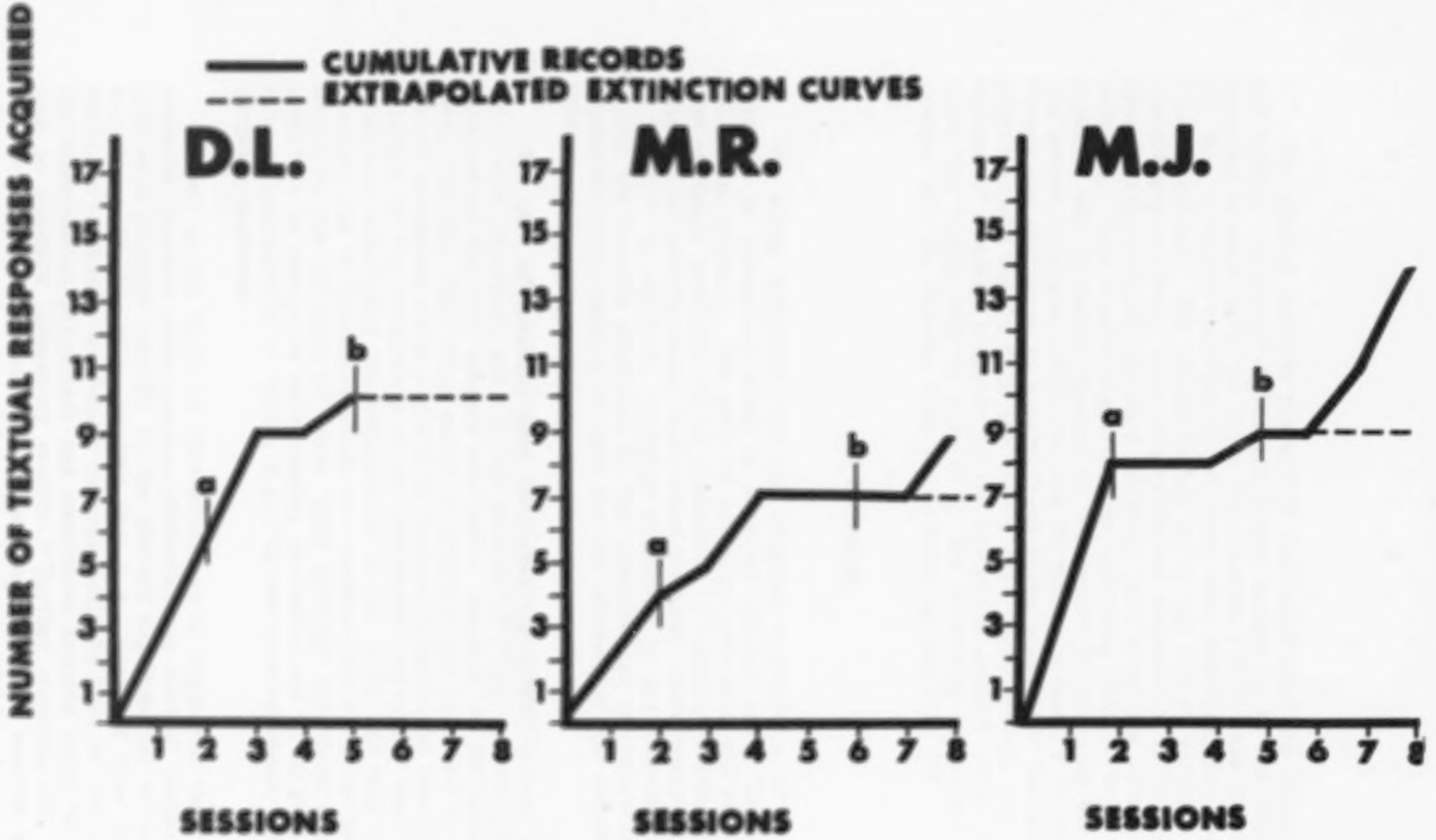

Fig. 8. For these Ss, the first condition included reinforcement which was discontinued at the point of the first mark on the curve. When S would no longer remain in the experimental situation, reinforcement was reinstated, as the second mark on the curve indicates. The dotted line commences at the point the S would no longer remain in the experiment and depicts the curve which would have resulted if reinforcement was not reinstated.

The general results for all *S*s indicated that the mixture of edible and trinket reinforcers plus the tokens backed up by the secret surprises appeared to work well, as Bijou and Sturges (1959) have shown; but there was some evidence that the reinforcers were weakening for some *S*s in the later sessions. The tokens backed up by the secret surprise seemed to exert heavy control. This was evidenced especially in two cases where experimental control weakened markedly just after the secret surprise was obtained. This result suggests that something similar to a fixed-ratio schedule was operative because of the method of relating the tokens to the secret surprise. That is, the 24 tokens necessary to secure the reinforcer was analogous to a 1:24 fixed-ratio schedule. The same scalloping effect should result from the use of this token system, and the observations of reading behavior in the situation support this. Furthermore, since the tokens were in view of *S*, and obtaining the secret surprise removed all the tokens, this constituted an explicit S^{Δ}.

Discussion

The study indicated that the original acquisition of texts is susceptible to laboratory study as a verbal operant under the control of visual verbal stimuli. The unit of behavior used with the sessions as a time variable produced curves analogous to cumulative records. Manipulation of reinforcement conditions produced characteristic changes in "rate." In addition, although different *S*s had somewhat different rates, the records generated by the experimental procedure were generally consistent with respect to rate and the effects of the experimental variables.

The unit of behavior used indicates the actual textual responses which were acquired; and, in the absence of other information, it was selected as the best measure available. Results of the experiment, however, indicate that other units of behavior are involved in the experimental situation which would also produce interesting records. As manipulation of the conditions of reinforcement indicated, the "reading" behaviors underlying the acquisition of the texts can vary widely in strength (as do behaviors which are incompatible with the reading). In addition, the strength of these "good working" behaviors appeared to be sensitive to change in experimental variables and to be related to the rate of acquisition of texts; e.g., in non-reinforcement, both units of response weakened.

Thus, on the basis of this study, it is suggested that the verbal operants (whether under echoic, pictorial, or textual control) could be used as a response measure in the present experimental situation. The time measure would then be a standard one, i.e., units of time in the experimental situation. Continuous records could be kept of the time *S* is in the experimental situation, and cumulative records would be closely analogous to standard laboratory records. Further research will be concerned with developing this cumulative "reading response" measure and with its relationship to the one used in the present experiment.

The texting program worked well in conjunction with the additional reinforcers. In constructing the program, it was found that simply presenting a word stimulus to a child with an accompanying auditory prompt was ineffective in bringing the child's vocal response under the control of the word stimulus. With this method the child could echo the prompt and be reinforced without looking at the words. The system of using pictorial prompts, where appropriate, and word discriminations for the nonpictorial words, removed this difficulty. Ineffective behaviors such as guessing were not strengthened in this procedure. The program moved gradually, with many trials on each textual stimulus. It was found that single textual stimuli could rapidly be worked into sentences and small "stories."

However, the results indicated that the texting program with only social reinforcers was not reinforcing for very long. In fact, alone it quickly produced escape behaviors of many kinds, finally culminating in a request to leave the situation for good. The introduction of the additional reinforcers contingent on the reading behavior reversed this, at least for the periods included in the study. This was, perhaps, the primary value of the reinforcers; i.e., they strengthened the behaviors of staying in the situation and working.

In view of the practical importance of improvements in the teaching of reading, and the feasibility of the application of operant-conditioning procedures to this task, further research is planned to extend the present findings. This research will investigate (1) the extension of the procedure to a program for developing units, e.g., letter and syllabic texts; (2) the development and exploration of a cumulative record based upon "reading" responses in the experimental situation, and the relationship of this record to curves based on the acquisition of textual responses as used in the present study; (3) the effects of intermittent-reinforcement schedules; (4) the effects of the "schedule" of pairing of tokens with the reinforcers; (5) the duration of the reinforcers; and (6) automation of the procedure.

V. Study IV:

A Reinforcer System and Experimental Procedure for the Laboratory Study of Reading Acquisition*

Arthur W. Staats, Karl A. Minke, Judson R. Finley,
Montrose Wolf, and Lloyd O. Brooks

Staats and Staats (1962) recently discussed the first acquisition of reading (i.e., texting) in terms of reinforcement principles. It was pointed out that reading acquisition was difficult for all children, in varying degrees. This discussion indicated that one reason reading is difficult for many children to acquire largely concerns the fact that the conditions of reinforcement are not propitious with respect to the availability and application of reinforcers. Reinforcement principles established in laboratory studies indicate that behavior may be most efficaciously shaped when reinforcers are made immediately contingent upon the behavior which one desires to strengthen. In their analysis the authors suggest that "...reading learning should be studied in a procedure involving the immediate application of positive reinforcers for attending to and working at the acquisition of textual responses."

On the basis of this conclusion the authors and associates began to construct a laboratory procedure for the investigation of reinforcement principles in the learning of reading (Staats, Staats, Schutz, and Wolf, 1962). Under this first experimental procedure six 4-year-old children were used in a study where each child was first trained upon individual words, then trained upon these words combined into sentences, and finally upon these sentences combined into short 'stories.' Eight daily sessions of forty minutes duration were employed for all subjects. For three children training was commenced without reinforcement and continued until the children refused to participate further. At this time the Reinforcement Condition was introduced. For the other three children the Reinforcement Condition was applied for the first two sessions, then the No-Reinforcement Condition was instituted until the children refused to continue, at which time reinforcement was reinstituted. The dependent behavioral measure consisted of the number of new textual (i.e., reading) responses the children acquired in each training session, as measured the day after the session. In addition, qualitative observations of the child's behavior during these sessions were recorded. The results indicated that the reading responses were acquired and that the attentional and work habits involved in the training were maintained under the Reinforcement Condition, but both types of behavior deteriorated when reinforcement was not forthcoming. The authors made the following conclusions:

> The study indicated that the original acquisition of texts is susceptible to laboratory study as a verbal operant under the control of visual verbal stimuli (p. 39).
>
> The *S*s acquired totals of 16, 17, and 17 texts, tested

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*This article is in press in *Child Development*.

> out of context. Thus, the operant-conditioning procedures, in these few sessions, proved to be very successful compared with the reading achievement which these Ss would make in their next year's work in kindergarten. The length of time these young children worked at a task ("attention-span") was directly a function of the response-contingent reinforcing properties of the situation (p. 37).

Nevertheless, in this first procedure, the program for the presentation of reading material was considered primitive, since it was manually administered, thus lessening the precision of experimental control which could be obtained by automating the procedure. In addition, the count of the new texts acquired per session constituted a rather crude measurement and was seen as only one possible dependent variable. The qualitative observations indicated that the strength of actual reading behaviors in the experimental situation (as well as competing behaviors) was capable of wide variation as a function of reinforcement. A continuous record of the reading responses, if cumulatively recorded, could produce a standard operant conditioning record which would be a sensitive learning curve for each child.

Furthermore, the first study indicated that the reinforcers used, while appropriate for the length of study involved, were beginning to lose their effect for one of the Ss toward the end of the 8 training sessions. Since the acquisition of reading is a lengthy process it is necessary to construct a reinforcer system which will allow the long-term study of this type of learning.

In addition, the program of reading materials was quite variegated, using words, sentences, and stories at different times, and could be expected to vary considerably in difficulty--thus it would impose certain characteristics upon a refined learning curve. In the study of the effects of various experimental conditions in the acquisition of reading, on the other hand, it is desirable to have a program of reading materials which does not itself impose effects upon the learning curves being produced. For this reason, it is necessary to construct a reading program which is more homogeneous in content than the one used in the first study.

Following these conclusions further work has been conducted to commence the improvement of the reinforcer system, to make the presentation of the reading materials more automatic, to cumulatively record the child's reading responses in the experimental situation, and to construct a reading program which is more homogeneous in character. The present study tests the efficacy and the durability of the reinforcer system which was developed and also the general characteristics of the experimental procedure and recording technique. These developments are important to the continued experimental study of reading, a class of responses significant in behavioral development and in later adjustment.

Method

Subjects

Three 4-year-old children (2boys, 1 girl), who would be entering the kindergarten of the Arizona State University Campus Laboratory School the following fall semester (1962), were volunteered by their parents for the experiment in the same manner as in the earlier study (Staats, Staats, Schutz, and Wolf, 1962). One female *S* quit before the pretraining period was completed and was replaced with another girl from the same population. Participation could be terminated at any time at the request of the child. *Ss* were transported to and from the Arizona State University Psychology Department Language Learning Laboratory by the female graduate assistant who served as *E* throughout the duration of the experiment.

Materials and Apparatus

Laboratory Facilities.--The general facilities consisted of a four-room complex: (1) a sound-proofed experimental chamber; (2) a small room containing automatic programming and recording equipment; (3) a room for the display and storage of toys; and (4) a play room equipped with a hobby horse.

Reading Materials.--A phonetic alphabet reading program was developed, using English symbols (letters and letter combinations) in conjunction with special identifying marks. A different identifying mark appears in conjunction with a symbol for each different sound which that symbol might assume. For example, $\underline{\overset{\mid}{a}}$ in the alphabet comes to control the 'a' response as in *father*, $\underline{\overset{\frown}{a}}$ controls the 'a' as in *fate*, etc. Thus, each symbol plus its identifying mark is meant to control a different verbal response.

Vowel symbols were presented singly, while consonant symbols were presented only in combination with a following vowel. Consonant-vowel combinations were selected which appear in at least three different familiar English words; consonants and vowels which could be used in this manner constituted the pool of symbols from which the vowel and consonant-vowel combinations (characters) were selected.

When a vowel was selected from the pool it was first presented alone, then in combination with all previously presented consonants with which it would combine into characters according to the above criteria. Each vowel or consonant-vowel combination was considered a new character. Each consonant, when selected from the pool, was combined with all possible previously presented vowels. Thus, prior material was continually re-presented, albeit in different combinations.

Only a portion of the possible characters was programmed for the present study, and the characters used were randomly selected from the basic pool. The above criteria dictated that the first symbol selected be a vowel. Therefore, in the early portions of the program consonants were sometimes drawn from the pool which could not be used at that time, since combinable vowels had not yet been presented. Such consonants were returned to the pool for possible later selection.

These characters were introduced into the program one at a time according to a complex circuiting formula. Each character was circulated through three differently programmed presentation phases: Phase *A* constituted 5 introductory trials of a character. Phase *B* constituted 15 subsequent training trials on that character, and Phase *C* constituted occasional presentations of characters so that no character was ever completely dropped from the program.

Once a sufficient amount of material had been introduced into the program to permit the circuiting of a variety of characters, then *A* trials for one character and *B* trials for previous characters occurred together in randomized groups of twenty, each group followed by a group of *C* trials. The number of characters in a Phase *C* group gradually increased as the program progressed.

The program was presented to *S* on 5 x 8 white index cards, each card representing a trial. On each card the appropriate character was typed in lower case primary letters, and below it appeared one matching and two non-matching characters. Thus each card was designed so that discrimination training could be carried out. For a vowel character the non-matching stimuli consisted of the same letter stimulus with non-matching identifying marks, e.g., if *â* was the appropriate character for that particular trial, the lower row characters might be *ā*, *ä*, *å*. For a consonant-vowel character the non-matching stimuli consisted of consonant-vowel combinations utilizing the same vowel but different consonants, e.g., if *h â* was the appropriate character for that trial, the lower row characters might be *h â*, *l â*, *h â*. The non-matching characters were randomly selected from the pool of characters which met the appropriate criteria. Finally, placement of the matching stimulus in the bottom row of characters was randomly determined.

Pretraining Materials

A list consisting of the various vowels and consonants in the pool of symbols was presented as an echoic task. Vowels appeared singly and consonants were presented in simple words. The words and vowels were listed in randomized order.

Thirty matching-to-sample discrimination cards utilizing pictures (simple line drawings) of familiar objects were constructed in a manner similar to the discrimination cards for the reading material.

Stimulus Presentation Apparatus

A vertical panel containing a small plexiglass window and three similar windows centered below it was mounted on a table in the sound-proofed room; a slight push on a window activated a microswitch. The printed portions of a program card could be viewed through the windows. Beneath each of the lower three windows was a corresponding button, and a press of the button below the correct window activated a marble dispensing device. A small red light was located in the center of the panel below the buttons and a doorbell-type pushbutton was on the table in front of *S*. A light on *E*'s side of the panel illuminated the stimulus card. This system is included in the accompanying diagram of the experimental chamber (Fig. 4).

The various manipulanda were connected to *E*'s control box as well as to the automatic programming and recording equipment in the next room. *E*'s control box consisted of a group of relays which controlled the sequencing of the reading response chain. Any response by *S* which occurred out of the proper sequence resulted in the automatic sounding of a buzzer. On the control box were mounted lights to indicate *S*'s position in the chain, a switch for selecting the correct matching stimulus position on each trial, switches for counting the various types of responses, and buttons for manual reinforcement delivery and manual buzzer presentation. Further, the cumulative recorder in the next room could be turned off or on by another switch at *E*'s disposal.

Reinforcing System

A marble dispenser, which when activated caused a marble to roll down a tube into a small box lying at its base, was located on the table in front of *S*, slightly to his right.

To the left of *S* was a large cabinet housing a Universal Feeder which when activated dispensed a plastic trinket, an edible (small candy, pretzel sticks, etc.), or a penny into an open bin adjacent to *S*. The feeder could be activated by a marble dropping into a funnel located at the top of the marble dispenser. When a marble was placed in this funnel, a bell inside the dispenser rang and the multicolored plastic front of the dispenser was briefly illuminated.

S could also place an obtained marble in one of four clear plexiglass tubes which were located in a row on a low shelf at his extreme right. Each tube held a different number of marbles: 10, 35, 80, or 150. Above each tube a toy was displayed which *S* had previously selected from the 'toy cafeteria.' Beneath each tube was located a small colored bulb which could be lighted by *E* when the tube was full. This system is also depicted in Fig. 4.

The toy cafeteria consisted of a room containing four display tables which were isolated from one another so that *S* could select toys from any table without the other displays being visible. Four samples of toys were available, the average cost of the toys in each sample being $.10, $.35, $.80, or $1.50. Thus, for each plexiglass tube in the experimental chamber there was a corresponding sample table in the toy cafeteria from which the child could select toys for display over the tubes. The $.10 sample consisted of 15 toys, and the other three samples consisted of 10 toys apiece. Whenever the samples were depleted below these amounts, they were restocked. These toys were obtained from local toy stores, and a heterogeneous population of toys was provided for each price value.

Recording Apparatus

The automatic contingencies and recording were handled by standard operant conditioning apparatus manufactured by the Foringer, Grason-Stadler, and Gerbrands companies. A Gerbrands cumulative recorder was used to record *S*'s responses, the delivery of a toy, and the operation of the Universal Feeder. The paper speed for the recorder was 15 centimeters per hour,

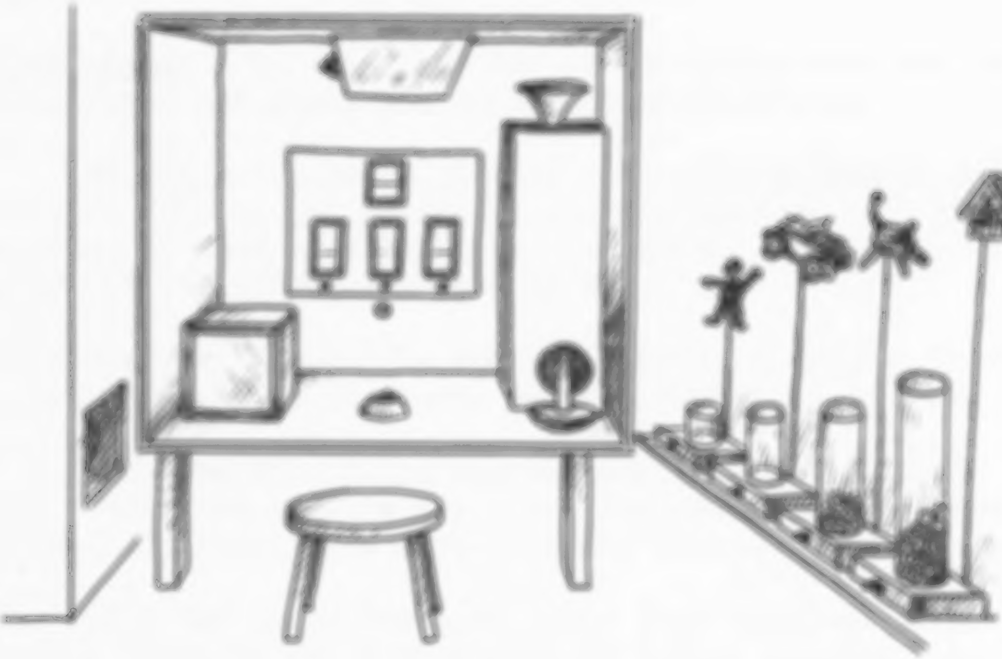


Fig. 4.--The laboratory apparatus for the experimental study of reading behavior. The child is seated before the center panel within easy reach of the various manipulanda which are involved in the reading response sequence. Letter stimuli appear in the small plexiglass windows in front of the child whenever he activates the pushbutton on the table before him. If a correct reading response sequence then occurs, the marble dispenser located at the child's near-right drops a marble into a tray positioned at its base. To the child's left is an open bin in the Universal Feeder cabinet into which are delivered trinkets, edibles, or pennies, whenever the child deposits a marble in the funnel located atop the marble dispenser. A marble may also be 'spent' for toys displayed at the child's far-right. Whenever the plexiglass tube beneath a toy is filled with marbles the child receives that toy. An intercom speaker at the child's left allows his vocal behavior to be monitored from outside the experimental chamber. The light at the top of the center panel was not used in this study.

and each response double-stepped the recording pen. A bank of four counters tabulated the total number of responses, correct and incorrect anticipations, and the number of marbles *S* deposited in the marble dispenser.

Occasionally the automatic equipment would malfunction during a daily session, causing a brief interruption of the procedure in order to make repairs. At such times *S* was removed from the experimental chamber and taken into the playroom.

Procedure

Pretraining.--On the first day of the experiment the child was brought to the playroom and given the following instructions:

> We are going to be playing some reading games, and you will be able to get prizes by earning marbles. I'll show you how to earn marbles in just a minute, but now let's pick out the prizes you want to earn.

The child was then taken into the toy cafeteria, placed in front of the table containing the $.10 items, and instructed as follows:

> Now from this table you may choose six toys that you would like to work for. You can choose any six you like. After you earn a toy you may take it home with you.

Next the child was shown the $.35 table from which he selected two toys; then he was taken to the $.80 and $1.50 tables respectively from which he selected one toy apiece. This method of selection provided enough toys in each value category so that if during a particular session the child were to deposit marbles earned that day into only one of the tubes, there would be a sufficient number of toys available in the experimental chamber for that day's session.

One toy from each category was randomly selected by *E* and mounted above the appropriate tube in the sound-proofed room. *E* took her seat behind the presentation panel, *S* was seated in front of the panel, and the experiment was begun. *E* initially presented the echoic task in which *S* was required to make a matching vocal response to the vowel or word spoken by *E*. *S* was first instructed to say 'jump'; upon emission of this response *S* was immediately reinforced with a marble. At this time instructions were given concerning the use of the marbles.

> If you want to, you may put your marble into this funnel, and the 'magic box' /Universal Feeder/ will give you a treat. Or, you may use your marble to work for one of the toys you picked out.

The relationship between the tubes and the corresponding toys above them was then explained.

The words on the echoic task list were read aloud one at a time, and *S* was reinforced with a marble for each correct echoic response (i.e., correct matching vocal response). The purpose of the echoic task was two-fold: (1) to assure that each *S* had a sufficient repertoire of vocal responses to echo rather precisely the verbal stimuli to be presented in the experiment; and (2) to bring echoic responding under the control of *E*. If *S* did not respond appropriately to one of the sounds presented, *E* withheld the reinforcer until a more precise echo was obtained. A limit of five such trials was set for any one sound.

Two types of pretraining discrimination tasks were then presented in order to establish the response chains appropriate to the actual reading task. Discrimination Task *A* used the picture cards to establish the following chain: (1) *S* presses the button mounted on the table in front of him and a card is presented; (2) *E* 'names' the picture in the top window, at which time *S* pushes the top window, turning on the red light, and echoes *E*; (3) *S* pushes the matching lower window, turning on the red light, and repeats the appropriate name; (4) *S* pushes the button below the matching lower window, delivering a reinforcer. This chain was established by *E* instructing *S* to perform appropriately at each step of the chain. As the training trials proceeded, *E* gradually lengthened the latency between *S*'s response and *E*'s next verbal prompt, and as the appropriate responses began to reliably occur prior to the presentation of the prompts, the prompts were dropped out altogether. Whenever *S*'s behaviors occurred in the wrong sequence the buzzer sounded, and *S* was instructed to restart the chain by pressing the top window. Thus, the buzzer was established as a discriminative stimulus for returning to this early step in the chain.

In Discrimination Task *B*, *S* was instructed to 'anticipate' if possible, i.e., name the picture in the upper window before *E* named it. On each trial *E* waited 10 seconds after presenting the card before giving the name of the picture. Correct anticipation responses by *S* were immediately reinforced without requiring *S* to perform the chain. The buzzer was sounded after incorrect anticipations; *E* then gave the correct name and *S* was required to go through the appropriate discrimination chain. Finally, if *S* did not anticipate at all, *E* gave the correct name at the end of the ten seconds, and *S* was required to complete the entire chain. Thus, there were three different contingencies in terms of the immediacy of reinforcement upon *S*'s possible anticipation behaviors. Reinforcement was forthcoming most immediately for correct anticipations, but *S* was reinforced more quickly for an incorrect anticipation than for no anticipation at all. This latter contingency was imposed in the attempt to maintain the general class of anticipation behaviors in some strength so that the contingency for a correct anticipation could be applied.

Reading Task.--Immediately following the completion of Discrimination Task *B* the first card of the actual reading program was presented. The procedures used in the reading task were identical to those employed in Discrimination Task *B*. However, all *S*s displayed some breakdown in the reading chain when the reading materials were introduced and occasional prompting of the appropriate chain behaviors was maintained for two of the three *S*s for the first few sessions.

During the entire experiment, including pretraining, *E*'s verbal responses to *S* were minimal; once the appropriate behaviors were established *E*'s only verbal behavior consisted of the presentation of stimulus materials. All attempts by S to interact with E were subjected to extinction, and E was particularly careful to avoid such behaviors as smiling, nodding, looking up, etc. in response to any such attempts at interaction on the part of S.

Reinforcing Procedures.--Each correct response (i.e., a correct anticipation or the terminal button-pressing response of the reading chain, whichever occurred on a given trial) was reinforced with a marble. S could place this marble in the marble dispenser to activate the Universal Feeder or in any one of the four plastic tubes. Thus, the delivery of back-up reinforcers (i.e., toys, edibles, and trinkets) was self-adjusting, and S could obtain an immediate back-up reinforcer of low monetary value or could use his marble to work toward more remote but higher-valued reinforcers.

When S placed his marble in the dispenser, he was given a plastic bag in which to place the objects obtained from the Universal Feeder. He was allowed to consume the edibles during the experimental session or he could take them home with him.

When one of the plastic tubes had been filled, E signaled that S had earned the toy associated with that tube by momentarily lighting the small bulb at the tube's base and by ringing the bell and flashing the light in the marble dispenser. The cumulative recorder was immediately stopped, the toy given to the child, and the marble tube was emptied. A new toy was then mounted above the tube, and the recorder was started. The delivery of a back-up reinforcer was performed with minimal interaction between S and E. Turning off the recorder during this procedure served to remove the delivery time from the record and to mark the moment of delivery.

Just prior to each day's experiment S was taken to the toy cafeteria to select enough toys to replace those earned the previous day. The experiment was conducted in 20-minute daily sessions, and it was initially decided to continue for forty sessions, if possible.

Results

Subject 1

In the daily session record for S 1 (see Fig. 5) the initial high rate in Session 1 represents response rate under the echoic task, as is the case for all S. The marked lessening of rate in this session indicates the commencement of Discrimination Task A; Discrimination Tasks A and B are not differentiated on the record. X indicates the beginning of the reading task proper. This marking convention will be followed on subsequent records.

In the first few sessions marbles previously placed in tubes were retreived by S and expended for the trinkets and edibles. S did not deposit her marble following every trial, but would accumulate marbles and deposit them several at a time. Following the receipt of her first

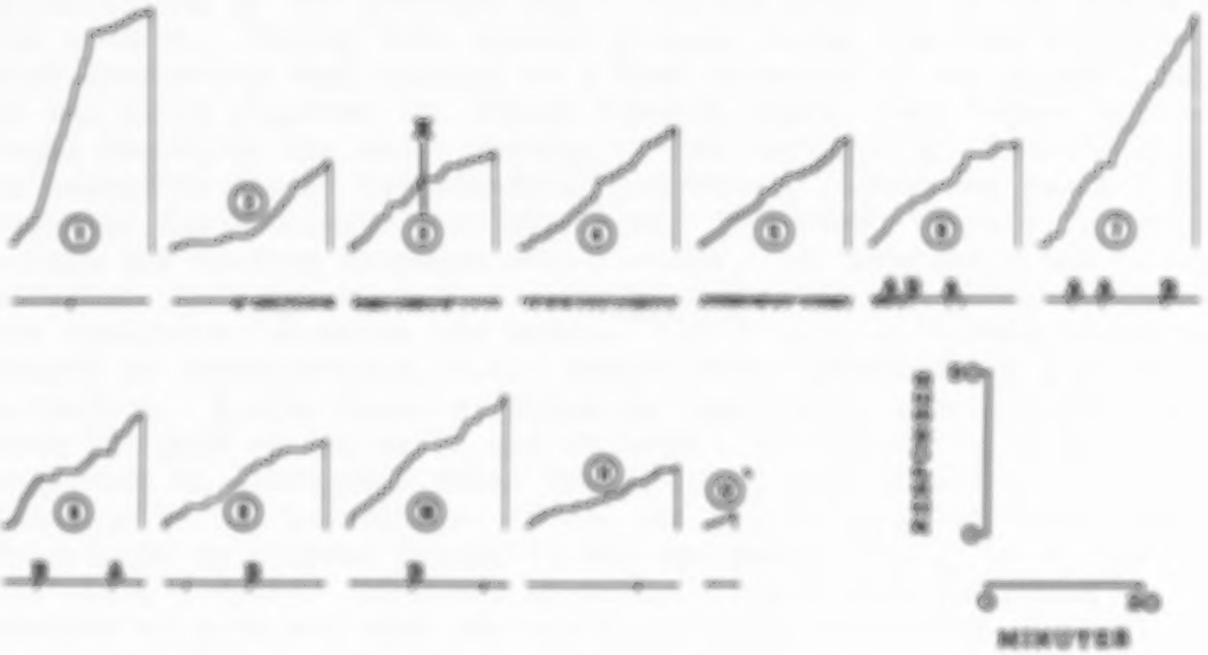


Fig. 5.--The cumulative records by sessions for Subject #1. Responses made prior to point X are those occurring during the various pretraining phases of the study. The first half of Session 1 shows the rapid rate during the echoic task; the latter half of the session and the first half of Session 2 show the lower rate obtained for Discrimination Task A; the more rapid rate occurring until point X is that for Discrimination Task B. From this point on the curves represent responses to the actual reading program. This sequence of events also occurs in following records. The slash marks located on the line below each curve represents the presentation of various back-up reinforcers. A indicates that a $.10 toy was exchanged for 10 marbles; B marks the presentation of a $.35 toy in exchange for 35 marbles; unlettered slash marks indicate that the child deposited a marble for some item from the Universal Feeder. This method of denoting reinforcing events will also be followed in subsequent records.

$.10 toy S began working for several toys at the same time, and would occasionally take marbles from one tube and place them in another. Sessions 9 and 10 show a pause following the receipt of a back-up reinforcer, the rate gradually increasing again until another back-up toy was earned, thus resulting in a 'scallop' effect on the record.

Session 7 shows the highest rate exhibited by any of the Ss used in this study; however, this rate may be accounted for by the inadvertent presentation of the previous day's reading material at the beginning of the session. During this session S again began hoarding marbles, this time depositing them several at a time into one of the plastic tubes. In the early sessions the actual reading chain, once begun, occurred in rapid sequence; the major portion of the variability observed in the records is accounted for by between-trial behaviors. After the session where the previous day's material was mistakenly presented, however, pauses appeared within the reading response chain itself. In Sessions 8 and 9, when the material again returned to its standard difficulty, S began playing with the apparatus (sounding the buzzer, etc.) and would emit irrelevant speech sounds as anticipations, i.e., sounds never presented by E in the situation. S also began to abuse the apparatus, stand on her chair, play with the toys on the wall, and attempted to interact with E. When E continued to extinguish these behaviors, S even struck E. In view of this behavior in the laboratory, it was decided to drop the child from the experiment to prevent damage to the equipment, the E, or to the child. The child's mother indicated at various times that the child was a behavior problem at home and that she was excessively demanding of adult attention and would not play by herself or with other children.

During the experiment S was presented with a total of 306 reading trials which included 34 trials presented twice (Session 7). 76.4% of the trials were anticipated and 40.5% of the total trials were anticipated correctly in Sessions 4 through 12. These figures are somewhat inflated by the number of correct anticipations obtained in Session 7.

Subject 2

The daily session record for S 2 is depicted in Fig. 6. This S's record is one of remarkable consistency, part of which is due to the fact that he almost never made anticipation responses to the verbal stimuli, and part to the absence of pronounced pauses. This consistency in response to the verbal stimuli enables observation of the effects of the reinforcement system. The results indicate that for this child the tokens immediately constituted strong and invariant reinforcers. The tokens did not have to acquire reinforcement value through pairing with the back-up reinforcers in various ratios. The verbal instruction and practice trials sufficied to determine their value, presumably to a large extent as a function of the S's previous training. An indication of the strength of the tokens as reinforcers is that the tokens maintained the child's behavior over periods as long as three or four training sessions during which no back-up reinforcer was received.

Close inspection of the records indicates, however, that the strength of the tokens was to some extent effected by the back-up reinforcer. That is, following the receipt of a back-up reinforcer there would be a

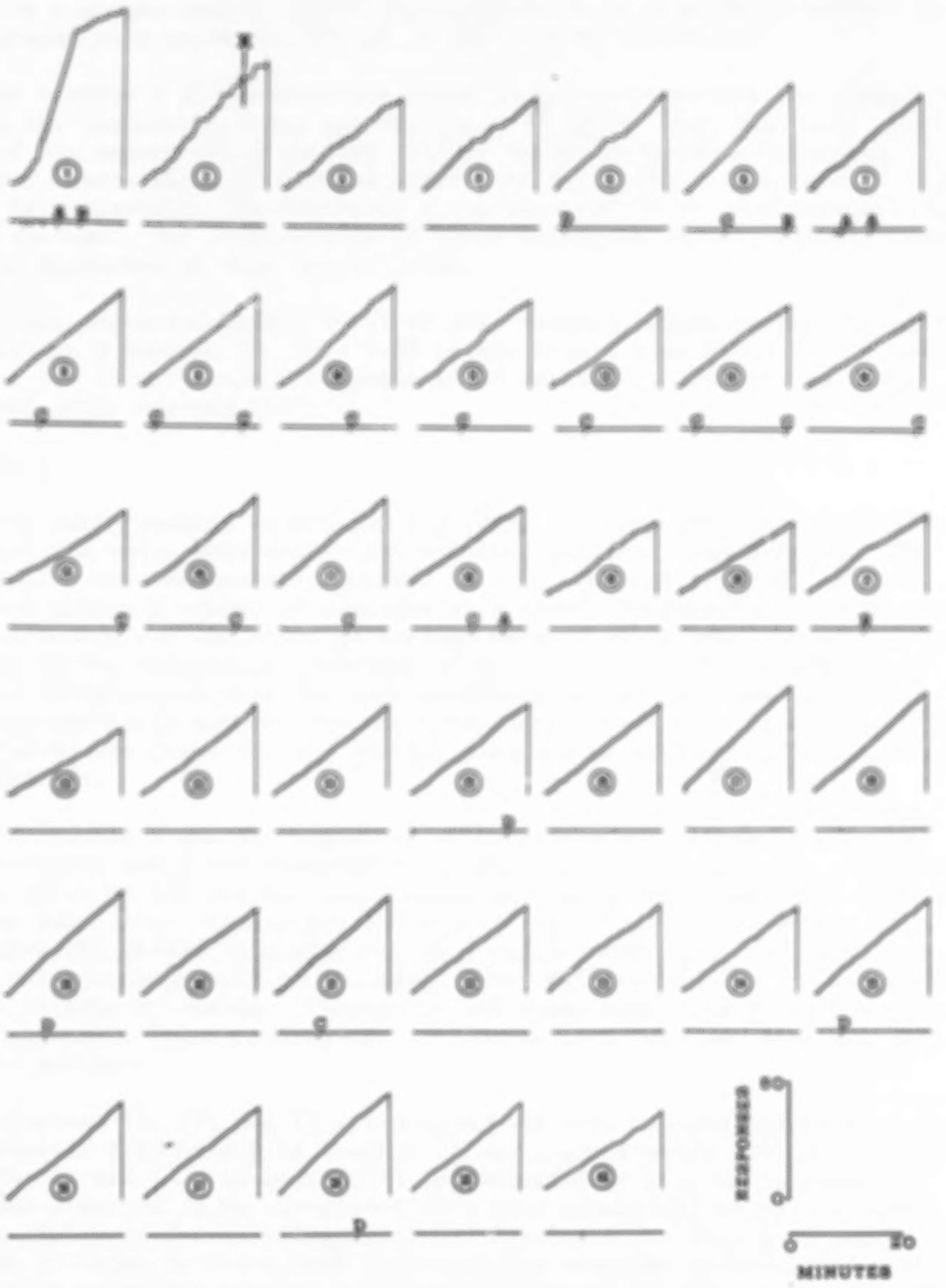


Fig. 6.--Cumulative records by sessions for Subject #2. Point X in Session 2 marks the beginning of the actual reading task. The presentation of back-up reinforcers is indicated as in the previous record, with the addition that this child's exchange of 80 marbles for a toy is denoted by a C, and D marks the exchange of 150 marbles for a toy.

slight reduction in the general rate of response, and sometimes there would be a slight pause. There also appears to be a tendency towards an accelerated rate prior to receipt of the back-up reinforcer.

In Session 3 a superstitious chain of verbal responses was shaped up during the ten second delay period, i.e., "I wonder what that is?" During most of the experiment S emitted similar verbal responses, including frequent descriptions of various aspects of the reading card stimuli (e.g., "That is a circle"). In addition, S was observed to be very restless in the situation. The implications of these behaviors for the reading procedure will be discussed in more detail later.

S was presented with a total of 1402 reading trials during the experiment. In Sessions 3 through 40, only 2.3% of the trials were anticipated, and 2.1% of the total trials were anticipated correctly. No anticipations occurred after Session 11.

Subject 3

The daily session record for S 3 (Fig. 7) shows more variability in the response rate, both within and between sessions, than did S 2. The variability between sessions appears to be a somewhat orderly, cyclical function across a number of sessions at a time. Whereas the reading chain was maintained for the other Ss through several early sessions of the reading program by the occasional prompting of E, this S received no additional support as this procedure for such prompting had not yet been developed. This may partially account for the exceptionally low rate in Session 3 as compared to the rates for the initial sessions of reading material for the other Ss.

In Session 5 and the beginning of Session 6 a lowering of response rate occurred and S was observed to be placing marbles in tubes according to the color of the marble, i.e., green marbles in one tube, blue marbles in another tube, etc. The subsequent depositing of marbles for items from the Universal Feeder then resulted in a rapid increase in response rate. These relationships will be discussed later with respect to the effectiveness of the reinforcer system. Throughout the experiment this S was also noted to occasionally hoard marbles and to take marbles from one tube and place them in another.

Sessions 11, 12, and 13 all utilized the same reading material, i.e., the material presented S in Session 11 was inadvertently presented again in Sessions 12 and 13. As opposed to the behavior of S 1, no increase in rate was observed to be correlated with this procedural error. However, the consistency of responding which had developed for this S in Sessions 7 through 13 began to break down following the repeated material and some of the lowest rates for the child ensued in Sessions 15 through 21. A similar effect is shown in Session 34, where the first 21 trials again consisted of repeated reading material. As can be seen the S's response rate improved under this condition, but the rate deteriorated in the following several sessions.

In Sessions 18 and 19 E substituted different toys for several of the toys mounted above the tubes. Session 21 clearly shows a scallop effect correlated with the placing of several marbles at once into the dispenser.

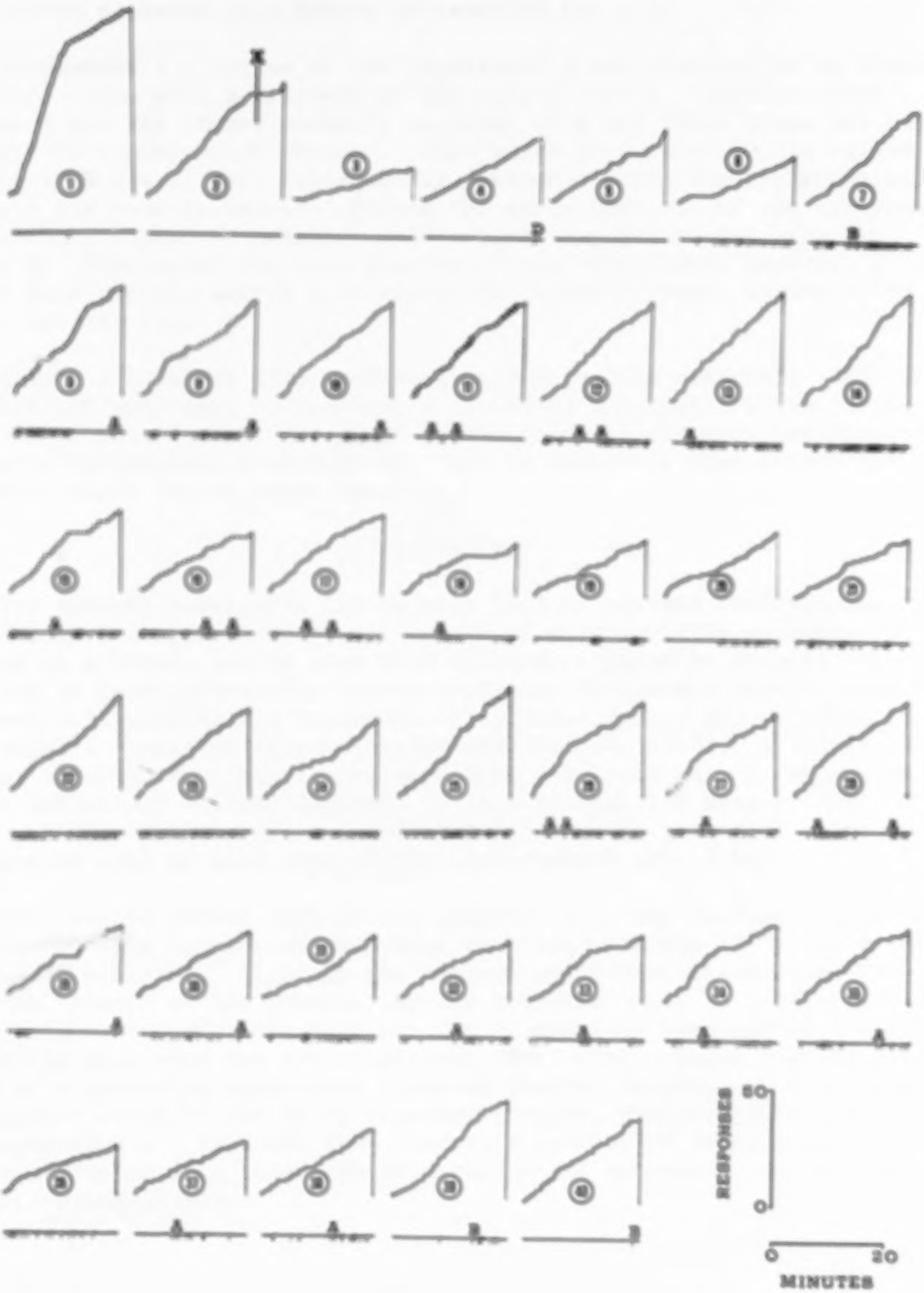


Fig. 7~~6~~.--The cumulative records by sessions for Subject #3. The sequence of pretraining tasks occurs until point X, at which time the reading program was introduced. The occurrence of back-up reinforcers is indicated below each curve as on the previous subjects' records.

This effect is similar to that noted for S 1 (Sessions 9 and 10), and can be observed to occur in a number of sessions for S 3.

Throughout the course of the experiment S was observed to be sharing his reinforcers with a playmate at his baby sitter's. Candies which neither S nor his friend normally consumed were not taken home, but were left in the experimental chamber. Just prior to Session 39 the friend ceased staying with S's sitter; subsequently S began working for higher valued toys and his rate increased. During the early portions of the experiment S frequently talked to himself, seldom directing his verbal behavior toward E. Throughout the last quarter of the experiment, however, S became more verbal, asking E to repeat the verbal prompt, asking if he should push a button, etc.

S made a total of 1310 responses to the reading material; this figure included 108 responses to previously presented material. 47.4% of the trials were anticipated, and 45.3% of the total trials were anticipated correctly in Sessions 3 through 40. It is uncertain what effect the repeated trials had on these results.

Discussion

The general conclusion can be made that an operant conditioning methodology and apparatus, plus a system of self-variable reinforcers backing up a token, can be used with children engaged in complex verbal learning to produce learning curves analogous to operant conditioning records obtained with more simple behaviors of children (e.g., Bijou, 1957) or with simpler organisms (e.g., Ferster and Skinner, 1957). Although the present study must be considered as having developed only an approximation of the laboratory control desired, it is a substantive step capable of being used in further studies, and it indicates the potential value of the approach as well as what some of the improvements should be.

The results showed that it was possible to study reading acquisition behavior in this laboratory procedure over long periods of training with individual subjects. Although one subject was discontinued after 12 sessions because of the possibility her behavior would be destructive or injurious, two subjects were run for 40 sessions each and were still responding well when the experiment was terminated. These results plus those of a preceding experiment (Staats, Staats, Schutz, and Wolf, 1962) and another which is yet to be reported (Staats, Finley, Minke, and Wolf, in preparation), indicate that long-term studies of reading acquisition may be conducted with this type of experimental procedure and this type of reinforcing system.

2

Response Measure

The apparatus worked well and it appears possible to treat these reading behaviors as operantly conditioned responses, recording the responses cumulatively as any other free operant. However, it is realized that the behavior being manipulated in this experiment is actually a lengthy and complex chain of responses rather than a simple unitary response which occurs more or less instantaneously. As such, this imposed certain problems with respect to measurement, i.e., one point in the chain must be selected to represent the reading sequence for recording purposes. Since the reading chain itself appeared to be sensitive to the manipulation of experimental variables, and the initial responses in the chain were too far removed in time from the contingencies being applied to accurately reflect the action of these contingencies, the delivery of a reinforcer (marble) was selected as the point in the sequence to record as this event always occurred as a function of the terminal response in the reading chain or following a correct anticipation.

It is also true that 'consummatory time' (time of eating edibles and playing with toys) was to some extent included in the records and produced an effect upon the curves. For instance, even though the delivery of a back-up reinforcer contingent upon the filling of a tube was removed from the record, most toys were manipulated for some period of time before work was resumed, and some of this manipulation time is reflected on the record. Thus, pauses after the receipt of a back-up reinforcer are probably to some extent attributable to the normal pausing effect usually found with ratio schedules as well as *S*'s manipulation of the toy. Long (1962) has reported similar ambiguity in records in terms of sensitive effects in experiments with children utilizing trinkets as reinforcers. Further, consummatory time could be somewhat affected by the method used by *S* to dispense the marbles. That is, more time was required for *S* to deposit his marbles so as to activate the Universal Feeder than was required to deposit his marbles in the tubes. In addition, all *Ss* at times would hoard marbles, thus depositing them only after several responses had been made, resulting in even further reduction in consummatory time. In future studies an attempt will be made to completely remove this source of ambiguity from the record so as to make the record even more sensitive to experimental variables.

In spite of these confounding effects the method of recording appeared sensitive to the various reinforcing contingencies. For instance, there was some general effect for all *Ss* associated with the receipt of a back-up reinforcer. For two of the *Ss* this took the form of a scallop effect, rather than a simple pause or reduction in over-all rate. Further, this method of recording over an extended number of sessions permits more general observations to be made, e.g., the records for all *Ss* indicated that the response rate tended to vary in an orderly fashion over several sessions at a time rather than varying unsystematically from day to day.

Program

The experimental program employed in the study utilized a portion of a phonetic alphabet which can present a different stimulus character for each possible English phoneme. The alphabet was developed in such a manner that these characters could later be combined into words without altering normal English spelling. This was done by assigning special identifying marks to existing English letters and letter combinations. The alphabet is versatile to the extent that only a few words (commonly-used foreign words) cannot be handled.

For purposes of homogeneity in the experimental program the phonetic characters were never combined into words. Consonants were never presented by themselves, but always in combination with a vowel. This procedure was followed in order to avoid the behavioral artificiality of having Ss make discrete speech sounds to individual consonant stimuli, these speech sounds not truly representing the total number of sounds the consonant might take when employed in words.

At this stage of the systematic investigation of reading acquisition the primary purpose of the study was not to construct an efficacious reading program, only one which had good experimental characteristics (e.g., homogeneity). Thus, the program was not arranged so that it moved in a gradual fashion, with mastery of materials occuring before new material was introduced. As a consequence, it might be concluded that the children's rate of responding was depressed over what would have occurred had the program been more propitious--as is shown by the effects upon response rates for the two children who were inadvertently presented material repetitiously. A more gradually moving program of presentation would also be expected to be less aversive to children (see Staats and Staats, 1962) and thus would require less reinforcement to maintain strong reading behavior. Further study will be made of these aspects of the reading procedure.

Even though the reading program was designed only to study the behaviors of the child in the initial phases of reading acquisition rather than to produce an extensive reading repertoire, two of the subjects showed by their percentage of correct anticipations that they were indeed acquiring textual responses. Had the program been such that it shaped general anticipation behavior in the other child, a similar result would probably have been shown. In addition, the two children who participated for the 40 sessions continued to work attentively at the reading task, and each child completed more than 1300 reading trials during the experiment.

The results indicated that the special contingencies applied to anticipatory behavior (in order to maintain the general class of anticipation behaviors in some strength so that the contingency for correct anticipating could be applied) was effective if at least a moderate rate of such behaviors occurred initially. If, however, the rate was too low, the contingency did not maintain the behavior. Adjustments in the procedure will be introduced in later work to insure that the child makes anticipations, and that correct anticipations may be differentially strengthened over incorrect anticipations.

The reading materials themselves performed their function well. For example, as can be seen with S 2, when the rate of response of the child is steady, no characteristics are imposed upon the curve by the program--that is, no single part of the reading material appears more difficult than another.

Pretraining

The response sequences required to engage in this reading task were not simple, and the pretraining procedures appear to require better programming to introduce Ss more gradually to the reading task proper. Preliminary work done on the development of the reading program and pretraining materials utilized five-year-old Ss, and the results obtained indicated that a simpler pretraining task than was finally used (i.e., echoic task and Discrimination Task A) was sufficient to develop and maintain the required behaviors into the actual reading materials. But when four-year-old Ss were utilized, it immediately became evident that more trials were required to shape the appropriate motor sequence and anticipation behaviors, and Discrimination Task B was introduced. However, this modification seems to have had only a limited effect as two of the nine Ss employed in the two studies completed thus far have removed themselves from participation in the experiment during the pretraining period. And it was evident from all records that there was a decided drop in rate following the pretraining tasks. Thus, the transition to the reading materials should be made much more gradual so that it represents no decided increase in the difficulty of the behavioral task. Further improvements are therefore indicated for the pretraining aspects of the procedure.

Two interesting observations were made on the basis of work done with the pretraining procedures: (1) the rather precise differentiated sounds required by a phonetic alphabet were in the repertoires of both the four-and five-year-old Ss, and all Ss went through the echoic task with a minimum amount of shaping required; (2) after using simple pictures as the discriminative stimuli for establishing the response chain involved in the reading task, the later introduction of the various characters of the program presented no problem with respect to S's ability to discriminate among characters. It has been concluded elsewhere (Davidson, 1935) that children of this age have difficulty discriminating among certain letters. Early pilot work in this laboratory involving simple alphabet training, utilizing an experimental procedure similar to that employed in the present study but without a pretraining period, also suggested that there were a number of letters among which Ss had difficulty discriminating. The present study, however, indicates that the adequacy of the training of behaviors prerequisite to the discriminated behavior being measured may be an important variable in such a 'failure to discriminate,' i.e., such a 'failure' may merely be a procedural artifact.

Behavior Chain

The procedure used for developing the complex reading chain differed from the traditional methods utilized in lower animal experimentation.

The traditional procedure for chaining training involves establishing first of all the terminal response and then the preceding responses sequentially from this point. Each response in the chain is well established before the next response is introduced. In the present experiment, however, every response in the chain was introduced immediately, each response being elicited sequentially in the situation by appropriate verbal prompts. By presenting the chain in this manner and gradually 'fading' the prompts, it was found that this chain was developed in relatively few trials. This would seem to be an efficacious method when using children as subjects, assuming that the required behaviors had previously been brought under verbal stimulus control. However, it is suggested that when dealing with still younger subjects (or with mental retardates with language problems) who may not have as yet developed such verbal stimulus-response relationships, the traditional procedures may be more appropriate. To what extent one is able to capitalize upon prior learning experience (especially language learning) is a matter that can only be established by further empirical investigation. The present study does indicate that behaviors under the control of verbal stimuli are sufficiently well developed at the four-year-old level to enable investigators to introduce complex learning tasks in a relatively short period of time, thus avoiding the necessity for prolonged training of the individual responses required in the experimental procedure.

An important aspect of the behavior chain is the attentional behavior required in order to allow the reading responses to occur in the presence of the appropriate visual stimuli. That is, the subject must be attending to (looking at) the visual verbal stimuli while responding if those stimuli are to ever control the appropriate responses. In early pilot work it was found that often the children were making the correct verbal response while looking around the room, etc. In the present experiment S was required to point at the stimulus, depressing a plexiglass window covering the visual stimulus, as he made the verbal response. This insured a high probability of looking at the stimulus while making the appropriate response. Ferster (1962) has reported that he was forced to deal with the attentional behaviors of chimpanzees in a similar manner. While pointing to the stimulus is not incompatible with looking away, the discrimination task involved in the procedure required that the child look at the printed symbol at about the same time as he made the appropriate verbal response. In addition, the differential reinforcement of anticipations also had the effect of bringing correct attentional responses under control. As already stated, however, the procedure for ensuring anticipations must be improved, since two out of the seven children run in this type of study were not strongly conditioned to make anticipations.

It was found necessary to carefully monitor not only the attentional responses in the behavior chain, but the verbal and motor responses as well. If there were not discrete contingencies applied to each response in the chain, extraneous responses soon appeared and would be maintained for long periods of time. For instance, when the child was not required to return to the beginning of the chain upon the emission of an incorrect response, 'superstitious' (see Skinner, 1948) pointing behavior was found to develop. However, the experimental procedure itself apparently allowed for the development and support of some extraneous behaviors by the children. For example, the questions and descriptions of the visual stimuli which were emitted by S 2 were probably maintained by having E present the phonetic sound (conditioned reinforcement) at the end of the 10-second delay period which occurred for this child on most trials. The adventitious reinforcement of such behaviors which compete with the reading behaviors required in the situation could be avoided in future studies by insuring that the verbal prompts of E are only presented contingent upon behaviors which are appropriate to the task, e.g., looking at the stimulus card, being silent, etc.

In addition, the children were very susceptible to subtle and inadvertent responses of E which seemed to function as reinforcers in the situation. For example, it was found that extraneous verbal behavior on the part of S such as asking "What do I do now?" was shaped up and maintained by such responses of E as looking at the child, raising the eyebrows, etc. In fact, E was not aware of her behavior in the situation and its effect upon S until the relationship was noted by an outside observer. E required special training to avoid making such responses (which are strongly reinforced in other situations) to the verbal and motor behaviors of the children. With respect to this problem Sidman notes the following:

> Bijou and Sturges (1959), in reviewing some of the ways reinforcers have been used in studies with children, have pointed out that interactions between subject and experimenter can markedly alter the degree of control exercised by an ostensible reinforcer. The child brings with him into the laboratory a history of social interaction, and socially mediated factors such as signs of approval or expection from the experimenter may override the effects of reinforcers like candy or trinkets....[They] suggest that human subjects be given minimal instructions, that all reinforcers be presented by mechanical or electronic means, and that the experimenter have as little contact with the subject as possible (1962, p. 176).

Thus, it would seem important that the experimenter be aware of the various subtle aspects of his own behavior which may constitute reinforcers for the child and thus shape up behaviors which are irrelevant to or interfere with the task. In addition, this suggests that one development in the study of child learning may be to construct laboratory facilities in which the experimenter is not readily accessible to the subject.

Although the first subject was discontinued because of the possibility that her extraneous behaviors might have been harmful to the apparatus, the experimenter, or herself, the results of this child still have implications for further progress in the laboratory study of reading. That is, the potentially harmful behaviors (called 'atavistic' by Ferster, 1961) of this child must be considered as responses which competed with the required reading behaviors. The atavistic behaviors did not commence until after the period where the reading material was relatively easy, where the subject moved through the program quickly, thereby acquiring many reinforcers. In all probability, better programming would have maintained the working behavior of this child in greater strength, and thus the atavistic behaviors would have been less frequent.

In addition, by completely removing the experimenter from the room, and by making all the apparatus temper-proof and safe for the child (see Ferster and DeMyer, 1961), it would be possible to remove some of the sources of reinforcement for the extraneous and atavistic behavior of the child. One of the avenues intended for further development in this systematic study of reading acquisition is to make such improvements in the laboratory situation. Such developments would make it possible to use 'behavior problem' children as subjects and to study the procedures which are necessary for bringing their behavior under laboratory control, i.e., procedures in which such children could acquire a reading repertoire.

Reinforcement System

An earlier study using back-up reinforcers of trinkets, edibles, and small toys was ineffective for holding Ss at the reading task for any considerable length of time (Staats, Staats, Schutz, and Wolf, 1962). There were indications that Ss were satiating on these reinforcer, i.e., they became less and less effective reinforcers with continued presentation. Similar satiation effects when trinkets alone were employed have been reported by Long, Hammack, May and Campbell (1958). Further, to establish a stimulus as an exceptionally strong conditioned reinforcer, some sort of scheduling of the back-up reinforcing system has been indicated (Zimmerman, 1957). This principle was utilized in the present procedure by permitting S himself to 'select' the scheduling contingencies, i.e., the child could obtain a reinforcer for his token on a 1:1, 1:10, 1:35, 1:80, or 1:150 ratio of reinforcement, and varying among these alternatives constituted a variable-ratio sdhedule of reinforcement. Further, such a system allowed the reinforcing system to shift with variation in the child's momentary and long-term deprivation and satiation conditions. That is, under 'deprivation' for a particular toy the child could deposit his tokens so that he could eventually obtain the toy. However, as his deprivation of trinkets or edibles increased, or as the value of the tokens in maintaining his behavior decreased, he could deposit one or more marbles in the machine and receive immediate reinforcement through the receipt of the edibles and trinkets. Stoddard, Sidman, and Brady (1960) successfully used a somewhat similar type of reinforcing system with adults.

The present study indicates that the type of reinforcing system ddvised herein and applied to four-year-old children is quite effective for studies of long duration--an essential constituent of any procedure to study the development of a complex human behavior. As Sidman (1962) indicates in the following passage, it would seem that some such reinforcing system is necessary for work with humans where it is not possible to place the organism under deprivation for primary reinforcers.

> Ultimately, exchangeable tokens are probably the most feasible solution. If the experimenter cannot achieve adequate control over deprivation conditions, he should turn completely in the other direction and make use of generalized reinforcers. By using tokens, which can be exchanged for a wide variety of reinforcers, he can take advantage of whatever deprivation is currently effective in his subjects (p. 175).

It should be pointed out that the voluntary nature of the participation placed a very stringent test upon the reinforcing properties of the training situation. Not only was effortful behavior demanded of the children (involving consistent attentional behavior, discriminations, and so on), but the training situation was competing with the free play the children would otherwise have been enjoying, and it cannot be compared to nursery school or kindergarten where attendance is compulsory. When attendance is compulsory the reinforcers need not be so strong--only stronger than those which would be enjoyed in competing alternative activities, e.g., daydreaming, doodling, and so on. Thus, the efficacy of the reinforcing system in maintaining reading in the present procedure was considerable and would be expected to function even more effectively in the usual situation of compulsory attendance.

One source of inadequate control in the reinforcer system used was the method of assigning 'reinforcing value' in accordance with the monetary value of the toys. It was uncertain whether the price of an object actually corresponded to its degree of effectiveness as a reinforcing stimulus. Certainly the more expensive toys (those which also required the most tokens in exchange) were larger and more durable objects, and if size and durability are dimensions of reinforcing value then it could be said that such toys were the stronger reinforcers. However, because of contingencies operative outside of the laboratory situation, a ten-cent yo-yo may effect a greater amount of responding than a more expensive game or puzzle. The procedure of equating price with reinforcing value was decided upon primarily because of its convenience for the experimenter. However, it is suggested that in future studies of this nature a technique could be developed for having each subject select and rank in order of preference a number of back-up toys from a large array of toys, or from several subsets of toys. Such a procedure might better insure that different weights of reinforcers were available for a given subject, and that the different amounts of tokens required for toy exchanging actually corresponded appropriately to the different values of reinforcers.

Another possible drawback in the present system was the fact that the tokens could be manipulated freely by the child, e.g., he could play with the marbles or switch them from one tube to another. It is difficult at this time to judge the desirability of such a system since, on the one hand, it allows the child to arrange the delivery of a back-up reinforcer to accomodate momentary fluctuations in his state of deprivation with respect to the reinforcers, but on the other hand, this system also permits the child to self-administer reinforcers which may not be contingent upon reading behaviors. Thus, more study will be required to decide upon the most advantageous precedure for handling token placement and delivery of the back-up reinforcers.

The behaviors of all the subjects were shaped and maintained by the marbles during early sessions with relatively few pairings of the marbles with the back-up reinforcers available in the situation. Thus, the marbles had evidently acquired some reinforcing value during the children's prior conditioning history. That the initial reinforcing value of marbles may have differed for the several children is evidenced by comparing the behaviors of S 2 and S 3 during their early sessions. The consistency of responding on the part of S 2 shows that the marbles were immediately effective in the situation as reinforcers, and were capable of maintaining a high response rate for several sessions without being paired with a back-up reinforcer. However, that the conditioned reinforcing value of the marbles was not initially under strong laboratory control was particularly evident for S 3, who early in the procedure placed his marbles into the tubes according to marble color. The reinforcing properties of the marbles appeared to be weakening for this child, as evidenced by the low rate of response in Session 5 and the beginning of Session 6. But as he began placing marbles into the marble dispenser, thereby receiving pairings of the marbles with back-up reinforcers on a 1:1 ratio, the response rate accelerated. Thus, the conditioned reinforcing value of the marbles was re-established, this time under good laboratory control. This suggests that while it may be advantageous to employ a token with some history as a reinforcer, it is important to bring the reinforcing value under laboratory control as soon as possible, so that the token does not have a chance to weaken as a reinforcer. This could be accomplished in future investigations by providing more frequent pairings of the tokens with the back-up reinforcers in the early sessions.

VI. Study V:

An Application of Mowrer's Sentence Conditioning Paradigms in Developing Evaluative Meaning

Richard E. Schutz and Harold Naumoff

Mowrer has presented four laboratory paradigms to explain the function of the sentence as a conditioning device. He distinguishes thing-thing, thing-sign, sign-thing, and sign-sign conditioning sequences. If cheese is paired with shock, a rat should turn away from rather than eat the cheese. Thing-thing communication has occurred. If a tone is first paired with shock, and then paired with cheese, eating should be inhibited in the presence of the tone. This is a thing-sign sentence. If a blinking light is paired with cheese and then paired with shock the light should inhibit eating of the cheese. This is a sign-thing sentence. Finally, assume that a tone is paired with shock and a light is paired with cheese. Then if the tone and light are paired, the light should now inhibit cheese eating. This is true language, a sign-sign sentence.

Each paradigm is thus a combination of conditioning sequences carefully arranged to produce a mediaton response which "communicates" meaning. The original paradigms were developed using stimuli appropriate for an infra-human organism, the rat. The present research involved analogous paradigms but utilized experimental procedures and stimuli appropriate in dealing with the verbal behavior of children.

Four separate experiments were conducted concurrently with independent random samples of children from the same population. Each experiment sought to develop positive evaluative meaning in one of two nonsense syllables and negative evaluative meaning in the other syllable as measured by a semantic differential instrument. The conditioning procedures, diagrammed in Figure 8, involved the nonsense syllables as CS. UCS were either the presentation or withdrawal of tokens or additional nonsense syllables which had previously been paired with the tokens. Since the tokens were redeemable for a toy selected by S, it was hypothesized that presentation of a token would dependably elicit a positive evaluative mediation response while withdrawal of a token would dependably elicit a negative evaluative mediation response.

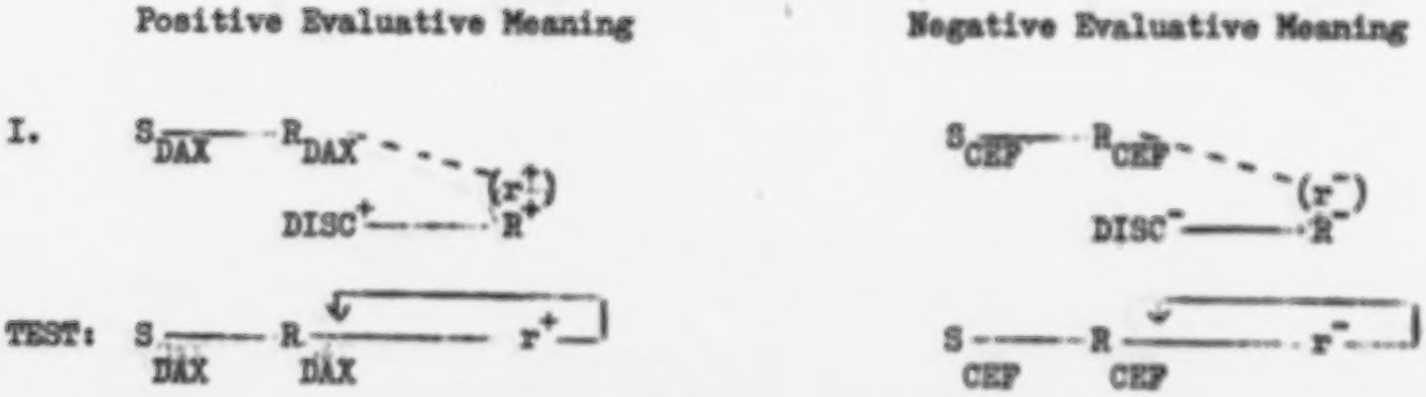
It was further hypothesized that the conditioned meaning reaction would mediate systematic judgments to evaluative scales of a semantic differential. That is, the syllable associated with the presentation of tokens on a first-order or higher-order basis should be judged positively while the syllable associated with the withdrawal of tokens should be judged negatively.

Method

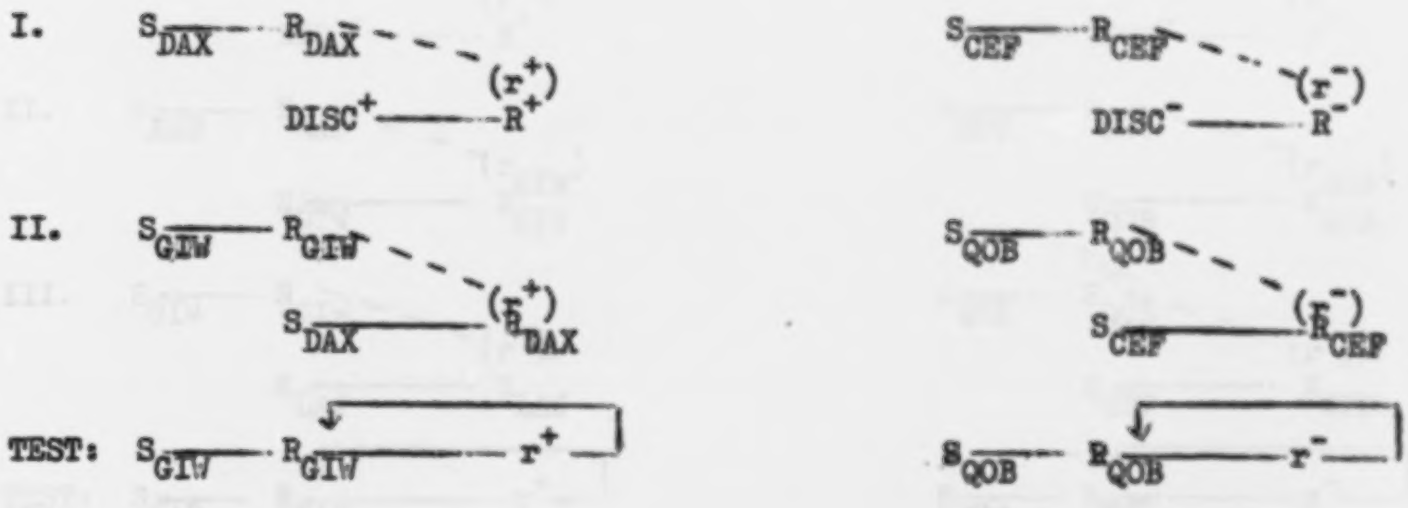
Subjects

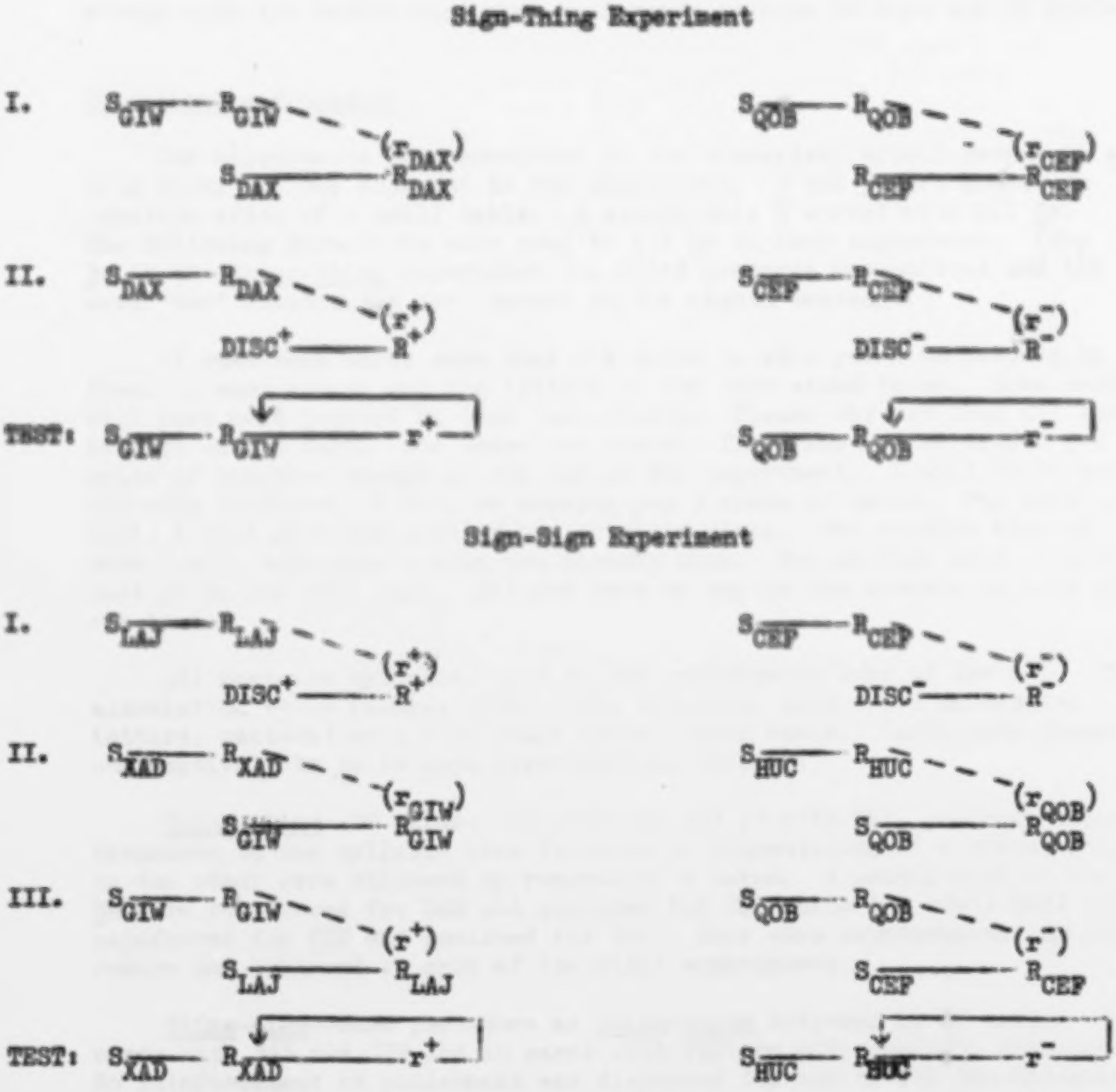
Ss consisted of 80 fourth and fifth grade pupils attending a single

Thing-Thing Experiment


Positive Evaluative Meaning
Negative Evaluative Meaning
I.
S_{DAX} R_{DAX} (r^{+})
$DISC^{+}$ R^{+}
TEST:
S_{DAX} R_{DAX} r^{+}
S_{CEF} R_{CEF} (r^{-})
$DISC^{-}$ R^{-}
S_{CEF} R_{CEF} r^{-}

Thing-Sign Experiment


I.
S_{DAX} R_{DAX} (r^{+})
$DISC^{+}$ R^{+}
II.
S_{GIW} R_{GIW} (r^{+})
S_{DAX} R_{DAX}
TEST:
S_{GIW} R_{GIW} r^{+}
S_{CEF} R_{CEF} (r^{-})
$DISC^{-}$ R^{-}
S_{QOB} R_{QOB} (r^{-})
S_{CEF} R_{CEF}
S_{QOB} R_{QOB} r^{-}


Sign-Thing Experiment

Sign-Sign Experiment
I.
S GIW
R GIW
(r DAX)
S DAX
R DAX
S QOB
R QOB
(r CEF)
R CEF
R CEF
II.
S DAX
R DAX
(r+)
DISC+
R+
S CEF
R CEF
(r-)
DISC-
R-
TEST:
S GIW
R GIW
r+
S QOB
R QOB
r-
I.
S LAJ
R LAJ
(r+)
DISC+
R+
S CEF
R CEF
(r-)
DISC-
R-
II.
S XAD
R XAD
(r GIW)
S GIW
R GIW
S HUC
R HUC
(r QOB)
S QOB
R QOB
III.
S GIW
R GIW
(r+)
S LAJ
R LAJ
S QOB
R QOB
(r-)
S CEF
R CEF
TEST:
S XAD
R XAD
r+
S HUC
R HUC
r-

Figure Caption

Figure 8. Diagram of experimental procedures. The Roman numerals indicate stages in the conditioning. "Test" indicates a semantic differential used to measure the extent of conditioning of meaning. Positive and negative meaning were conditioned and also tested concurrently at each stage. The subscripts identify the nonsense syllables used with half the Ss in each experiment. The figure depicts the procedures for only one of the counterbalanced groups in each experiment.

elementary school. *Ss* were randomly assigned to one of four experimental groups with the restriction that each group include 10 boys and 10 girls.

Conditioning Procedure

The experiments were conducted on the elementary school campus in a long empty hallway adjacent to the classrooms. *S* and *E* were seated on opposite sides of a small table. A single male *E* worked with all *Ss*. The following directions were read to all *Ss* in each experiment: (For *Ss* in the *thing-thing* experiment the third sentence was omitted and the word "two" substituted for "three" in the eighth sentence.)

"I have some cards here that I'm going to show you with letters on them. I want you to say the letters on the card aloud to me. Some cards will have more letters on them than others. Please say out loud all the letters on the card. See these red discs? The discs can be traded for a prize if you have enough at the end of the experiment. I will start you off with 10 discs. I will be showing you 3 kinds of cards. For some cards I will give you another one of these discs. For another kind of card I will take away a disc you already have. For another card, I will just go to the next card. All you have to say is the letters on each card out loud."

All nonsense syllables used in the experiments were of low (7% - 0%) association value (Glaze, 1928). The syllables were typed in capital letters, centered on 5 x 8" plain white, index cards. Cards were presented consecutively to *Ss* in each experiment as follows:

Thing-thing--20 cards: 10 with DAX and 10 with CEF, randomly sequenced. Responses to one syllable were followed by presentation of a token; responses to the other were followed by removal of a token. A random half of the *Ss* were reinforced for DAX and punished for CEF while the other half were reinforced for CEF and punished for DAX. This same counterbalancing procedure was followed in each of the other experiments.

Thing-sign--Same procedure as *thing-thing* followed by 20 cards: 10 cards with DAX and GIW and 10 cards with CEF and QOB, randomly sequenced. No reinforcement or punishment was dispensed for any of the two-syllable cards.

Sign-thing--Same procedure as *thing-sign* except that the two-syllable, non-reinforced cards were presented prior to the single-syllable, reinforced-punished cards.

Sign-Sign--(1) 20 cards: 10 with LAJ and 10 with CEF, randomly sequenced. Responses to one syllable were followed by presentation of a token; responses to the other were followed by removal of a token. (2) 20 cards: 10 cards with QOB and HUC, and 10 with GIW and XAD, randomly sequenced. (3) 20 cards: 10 with LAJ and GIW, and 10 with QOB and CEF, randomly sequenced. No reinforcement or punishment was dispensed for any of the two-syllable cards.

Semantic Differential Procedure

A semantic differential measure was administered to each S immediately following the conditioning treatment. A forced-choice item format was used rather than the Likert-type format traditionally used in semantic differential testing. The items in the measure paired the two nonsense syllables hypothesized to have acquired evaluative meaning as forced-choiced alternatives. S was required to choose the syllable he associated with each of a series of polar evaluative terms.

The following directions were read to all Ss:

"On this paper we have a list of words. I want to find out which of these letters you think belongs to the word here." (E pointed to the syllables and the words.)

S was then shown an example with directions as follows: "If you think that 'YUK' belongs to the word, make a circle around it. If you think that 'CUK' belongs to the word, make a circle around it, like this. (E demonstrates.) Make sure you mark a circle around one set of letters next to each word. Do this for each word. Do not skip any lines. If you don't know one of the words, tell me and I will tell you what it is."

The measure included the following 20 evaluative terms randomly arranged plus 12 randomly inserted buffer terms with zero order evaluative meaning: good, bad, fair, unfair, right, wrong, happy, sad, successful, unsuccessful, beautiful, ugly, pleasant, unpleasant, nice, awful, honest, dishonest, kind, cruel (Osgood, Suci, and Tannenbaum, 1957).

The items were serially numbered and dittoed double column on a single sheet. Each item consisted of an evaluative term typed in lower case and two nonsense syllables typed in capitals to its right. Consistent with treatment procedures, the following nonsense syllables were used as the forced choices in each experiment: Thing-thing; CEF DAX: Thing-sign and sign-thing; QOB GIW; sign-sign; HUC XAD. S marked the scale in the presence of the E.

Pilot work with the instrument indicated that some children's responses were controlled not by the semantic properties of the printed stimuli but by their configuration, pattern, position on the page, etc. It is of course impossible to identify or isolate the controlling stimuli for each S. To insure that whatever stimuli were exercising control were consistent, the terms good, bad, fair, and unfair were randomly included twice. Ss who made a different response to the first and second presentations of a term for two or more of the four terms were discarded. This procedure served only to eliminate Ss who responded inconsistently to individual items; any meaning assigned an item was accepted so long as it was assigned reliably. For all Ss included in the analysis only the first response was scored on the evaluative meaning measure.

Upon completing the semantic differential scale, S was allowed to select one of a variety of plastic rings and return to his classroom.

Results

The semantic differential data were analyzed first to determine if communication of meaning was affected within each of the experiments and secondly to determine if the experiments differed in effecting the communication of meaning. To make the first analysis, a common base is needed to compare the performance of the counterbalanced Ss within each experiment--those who were reinforced for a syllable vs. those who were punished for it. To obtain this measure the number of positive ratings assigned the test syllable shown in the left column of Figure 8 was added to the number of negative ratings assigned the syllable in the right column. This score was derived for all Ss.

The counterbalancing employed in the conditioning procedures insured that the left hand syllable had been associated with positive reinforcement and the right hand syllable associated with punishment for 10 of the Ss in each experiment while the reinforced and punished syllables were reversed for the other 10 Ss. Thus if the experimental procedures were effective in conditioning meaning, one counterbalanced group should score high, the other low.

Table 3 presents the medians, semi-interquartile ranges and results of the Mann-Whitney U test for the two counterbalanced groups within each experiment. It will be noted that the conditioning procedures resulted in the communication of evaluative meaning in all experiments except the thing-sign.

To determine if the four paradigms differed in the extent to which they communicated meaning, the results of the two counterbalanced groups within each experiment were pooled. The analysis was based on the number of positive ratings S assigned the syllable paired with positive reinforcement during conditioning plus the number of negative ratings assigned the syllable paired with punishment. Thus, the higher the score, the more effective the conditioning of meaning.

Table 4 presents the medians, semi-interquartile ranges and results of a Kruskal-Wallis analysis of variance comparing semantic differential performance in the four experiments. The analysis indicates a significant difference in the extent to which the four paradigms effected the communication of meaning.

Discussion

Success in attaching evaluative meaning to previously neutral nonsense syllables was attained in the application of three of the four paradigms. The reason for the failure of the thing-sign procedure is not immediately obvious. Certainly the mediation response involved is far less complex than in the sign-sign paradigm where meaning was communicated consistently. Furthermore, the same elements are involved in both the sign-thing and thing-sign procedures, the only difference being in the sequencing of the procedures. Although the authors have considered several

Table 3

Comparison of Semantic Differential Performance Within Experiments

Paradigm	Predicted High Group		Predicted Low Group		U	P
	Median	Q	Median	Q		
Thing-thing	17.0	3.0	4.5	2.9	10.0	.01
Thing-sign	10.8	2.3	10.5	3.5	44.5	.05
Sign-thing	14.1	2.6	5.0	3.0	0.0	.01
Sign-sign	14.5	3.2	4.5	3.3	1.0	.01

Table 4

Comparison of Semantic Differential Performance Between Experiments

Paradigm	Median	Q
Thing-thing	16.1	3.5
Thing-sign	10.5	2.2
Sign-thing	14.5	2.4
Sign-sign	14.5	3.4

$H=36.94$, $df=7$, $p < .01$

possible explanations of the thing-sign findings, no explanation has been found that is consistent with the other research results.

Inspection of the medians in Table 4 reveals that the inconsistent thing-sign results account for a good deal of the difference among the four paradigms. As might be expected, the direct thing-thing procedures were most effective. The effectiveness of the sign-sign procedures was less expected. The sign-sign results demonstrate that children can engage in fairly elaborate mediation processes. The findings thus appear to support Mowrer's analysis of the sentence as a conditioning device.

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